

AMSAT Operation Before, During and After the No Eclipse Period

2008 AMSAT Symposium
Atlanta

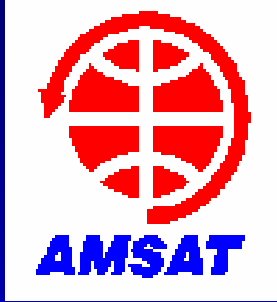
Gould Smith, WA4SXM
AMSAT VP User Services
AO-51 Command Station

AO-51 (Echo) History



- Improved Microsat (9.5" cube)
- Built by SpaceQuest ,Ltd
- 70cm and S band FM downlinks
- 2M FM & SQRX receivers
- 9600/38k4 bps AX.25 FSK Digital
- Multiple simultaneous mode combinations
- \$500k to build, \$110k launch

Sample AO-51 Operations in 2008



- **V/US FM repeater**
- **V/U FM repeater and L/U digital BB 'normal'**
- **V/U and V/U FM repeater**
- **L/US FM repeater**
- **L/S FM repeater & V/U FM repeater**
- **V/U SSB/FM repeater & V/U FM repeater**
- **L/U SSB/FM repeater & V/U FM repeater**
- **V/S FM repeater**

ao51-modes@amsat.org

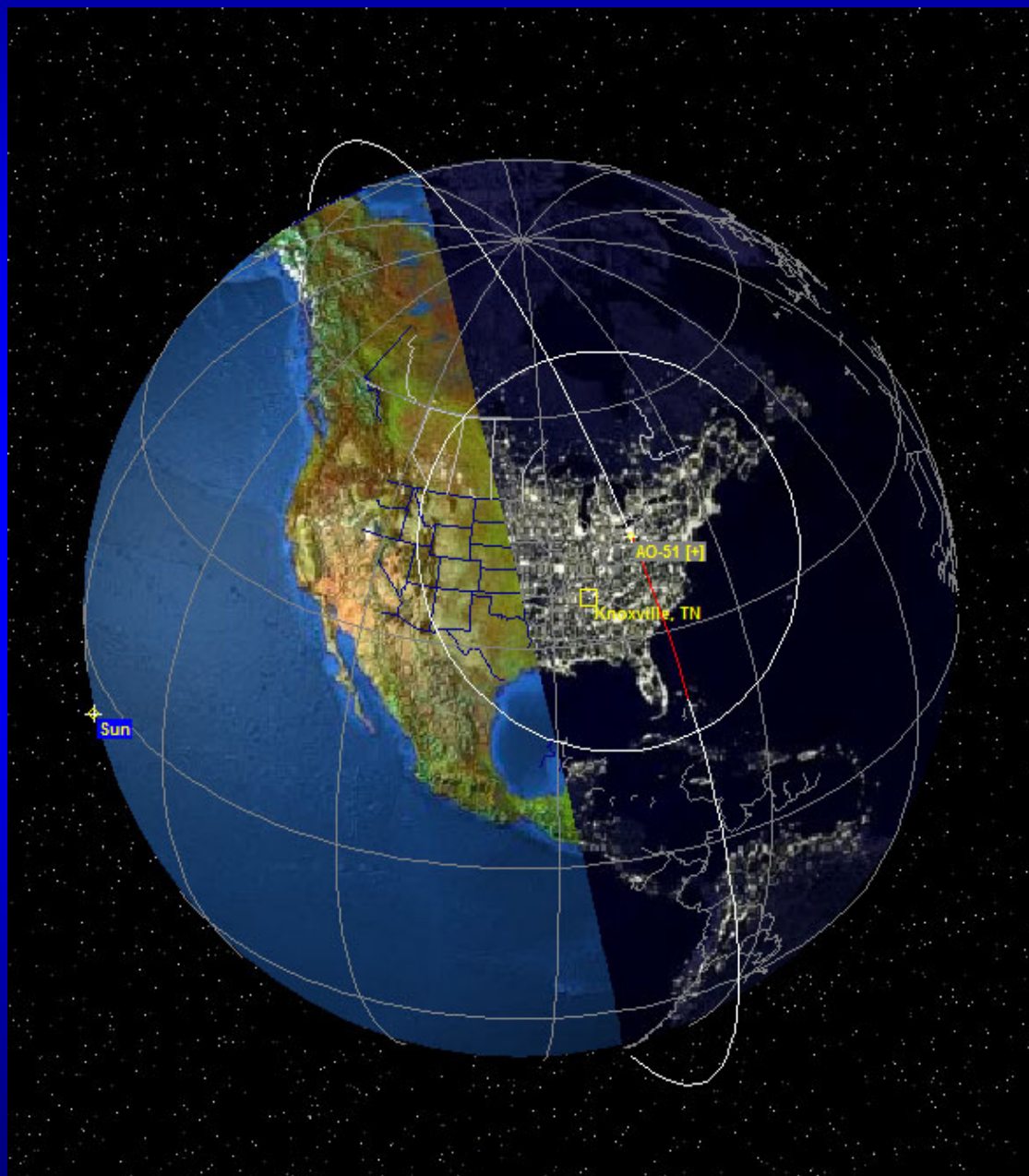
Changes to AO-51 Over the Last Four Years



- Orbit & Eclipses
- Battery Voltages
- Temperatures
- Solar Array Current
- Spin Rate



AO-51 Orbit



Sun-synchronous

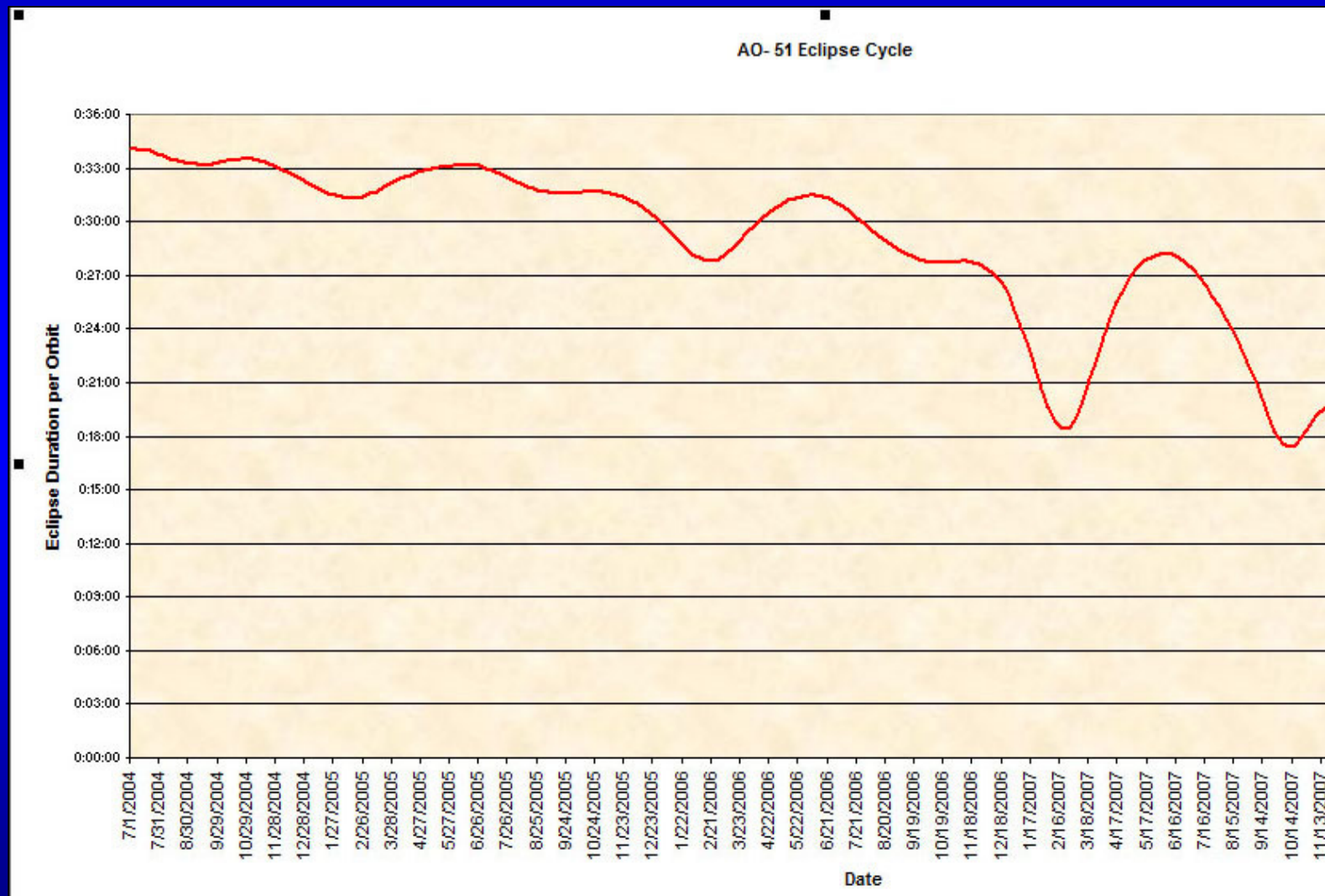
98.72° inclination

696 - 817 km altitude

~98 min orbit

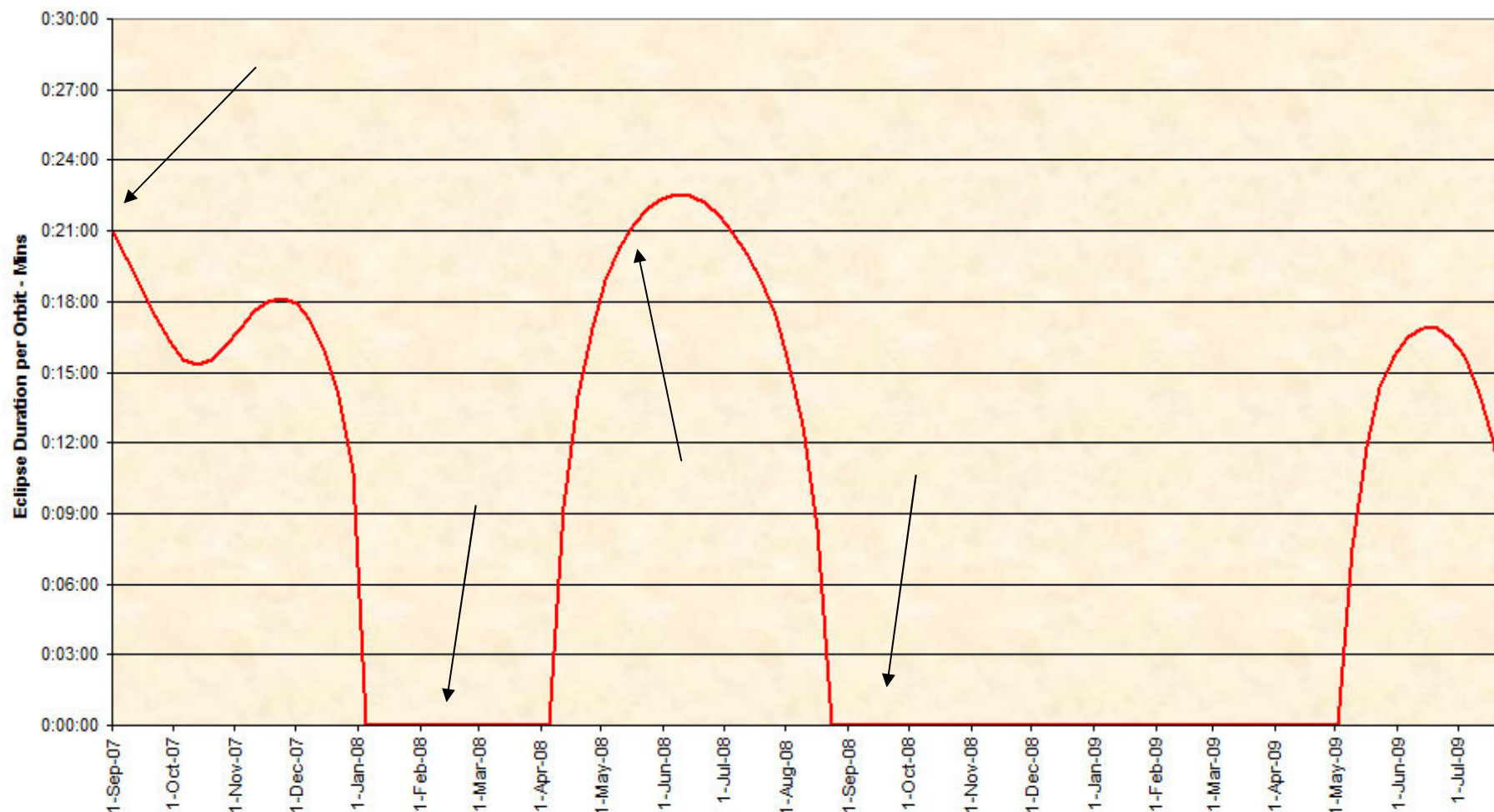
No eclipse period

AO-51 Eclipse Times 2004 - 2007



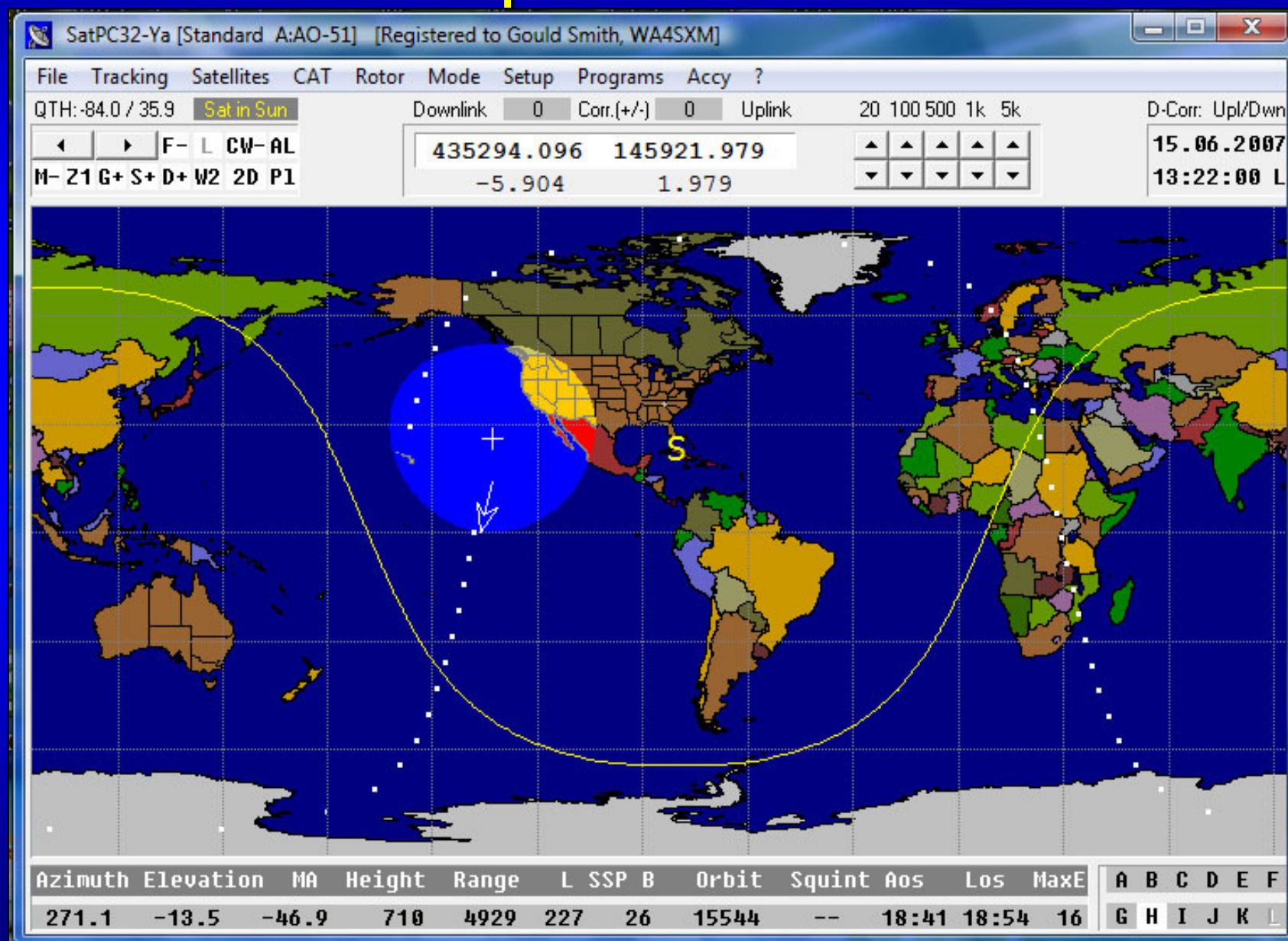
AO-51 Eclipse Times 2007-2009

AO-51 Eclipse Times 1st September 2007 to 30 July 2009

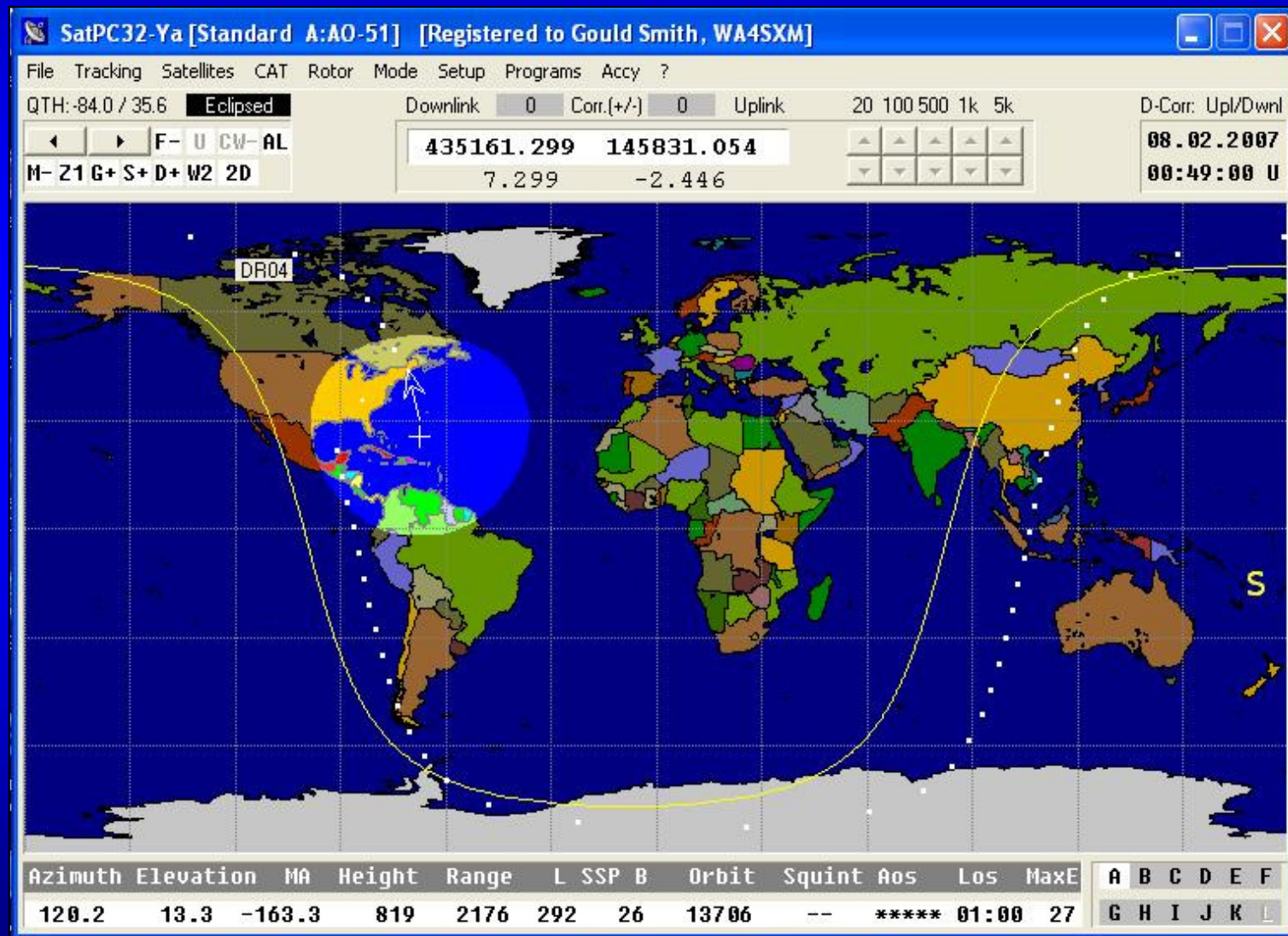


AO-51 Orbit 15 Jun 07

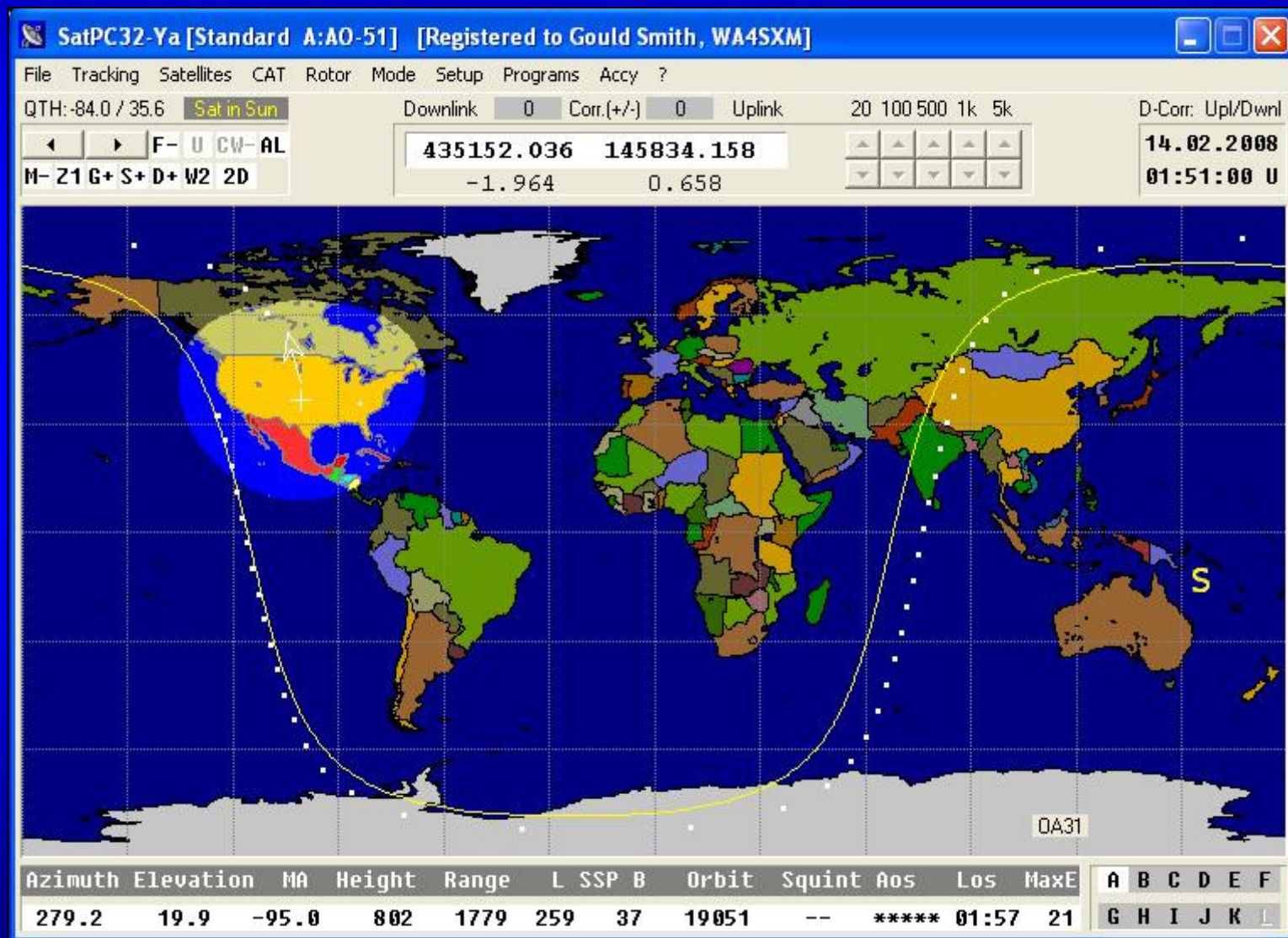
eclipse ~28:30



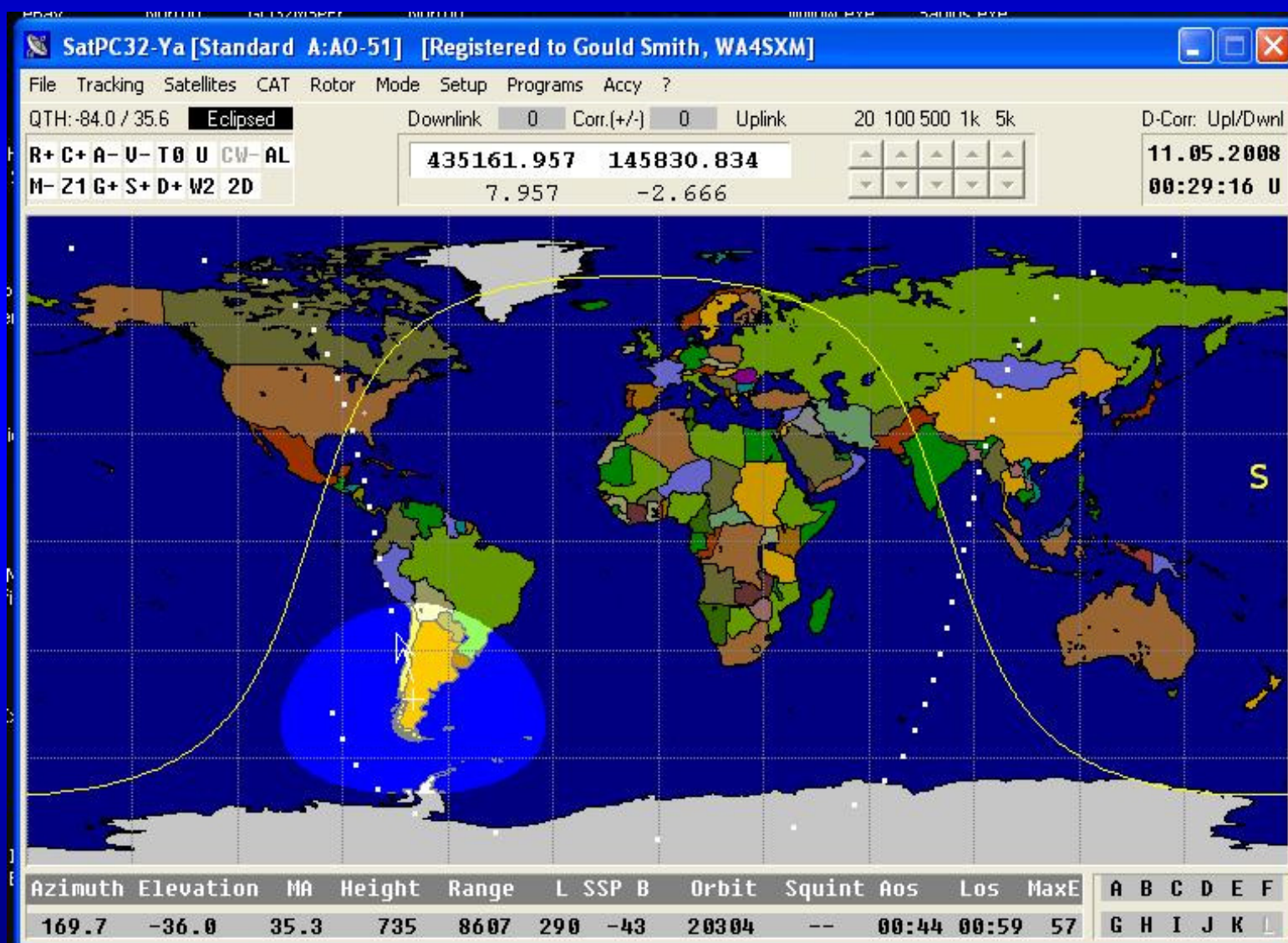
AO-51 Orbit 2 Aug 07 eclipse 24:30



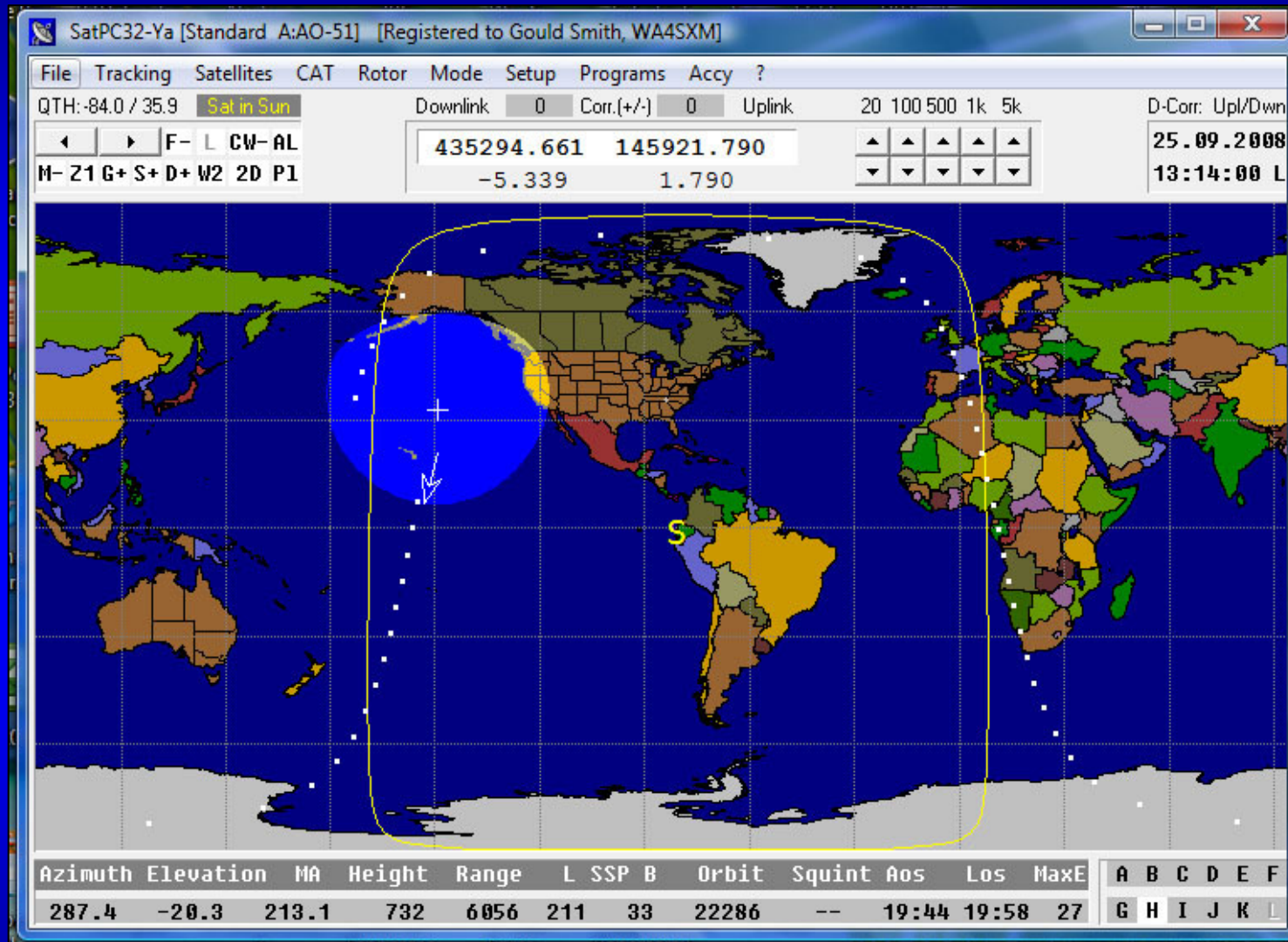
AO-51 Orbit 14 Feb 08 no eclipse



AO-51 Orbit 11 May 08 eclipse ~21:00



A0-51 Satellite Orbit

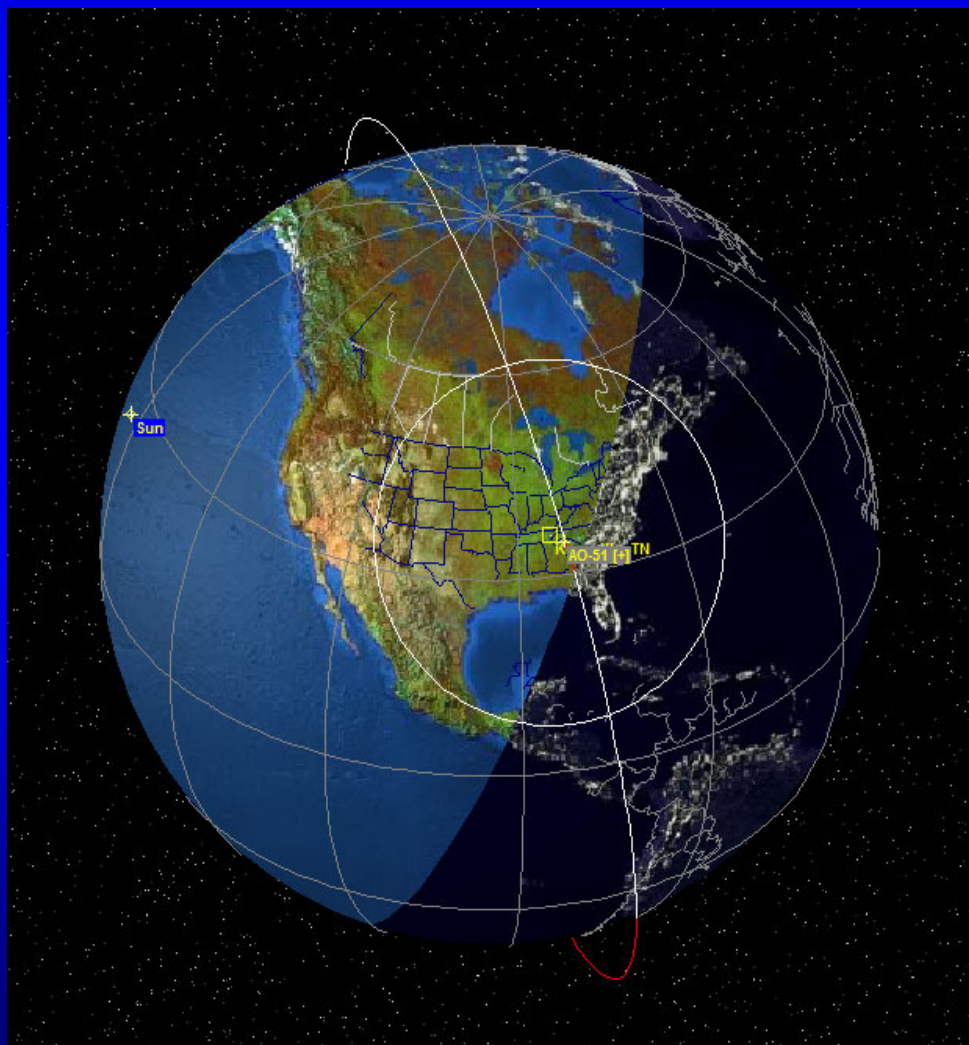


Close to autumnal equinox

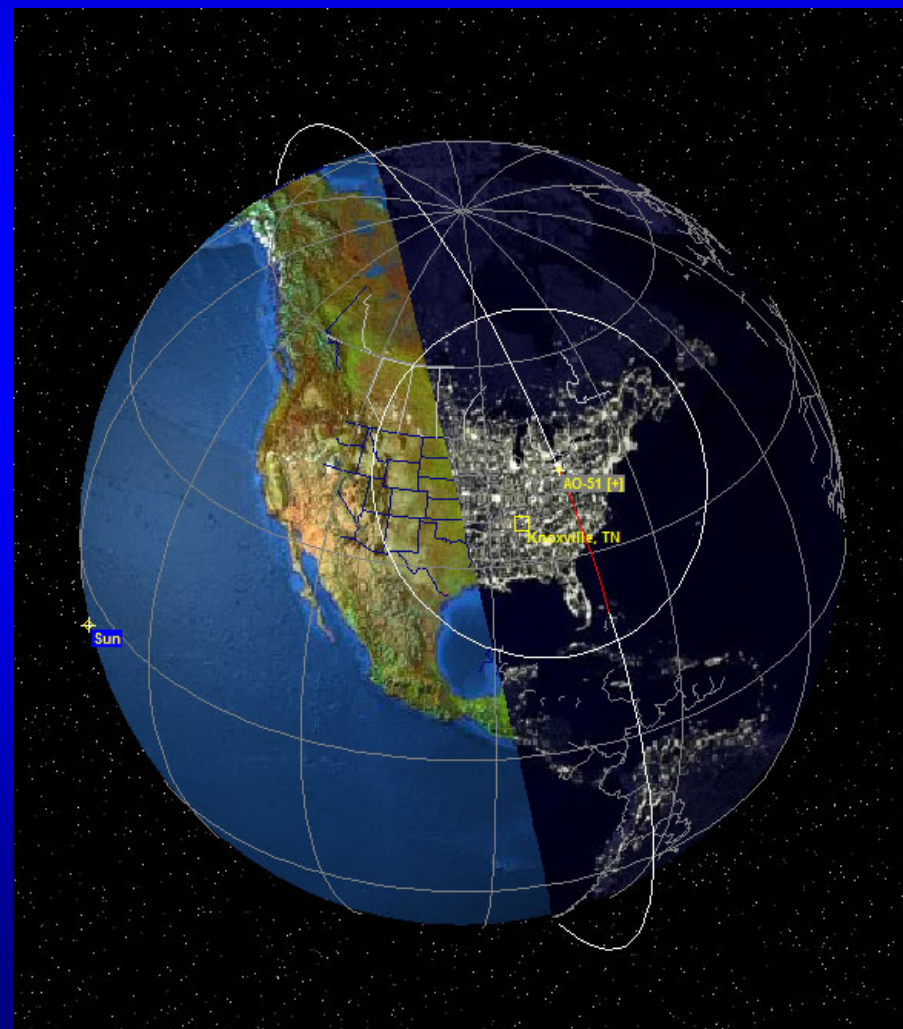
A0-51 Satellite Orbit



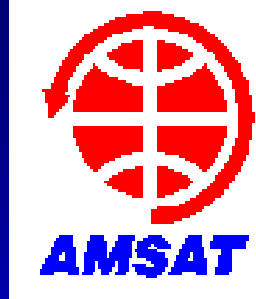
During Orbital
Eclipse Period 6/08



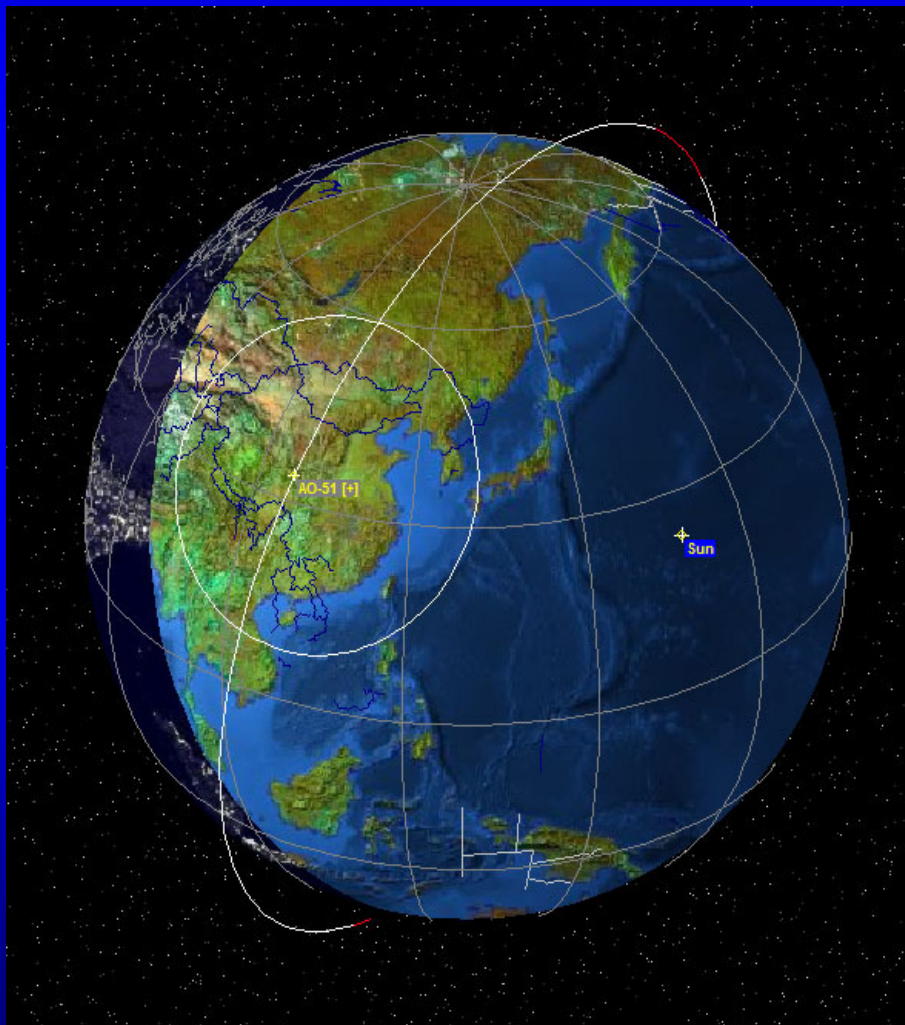
During Orbital No
Eclipse Period 10/08



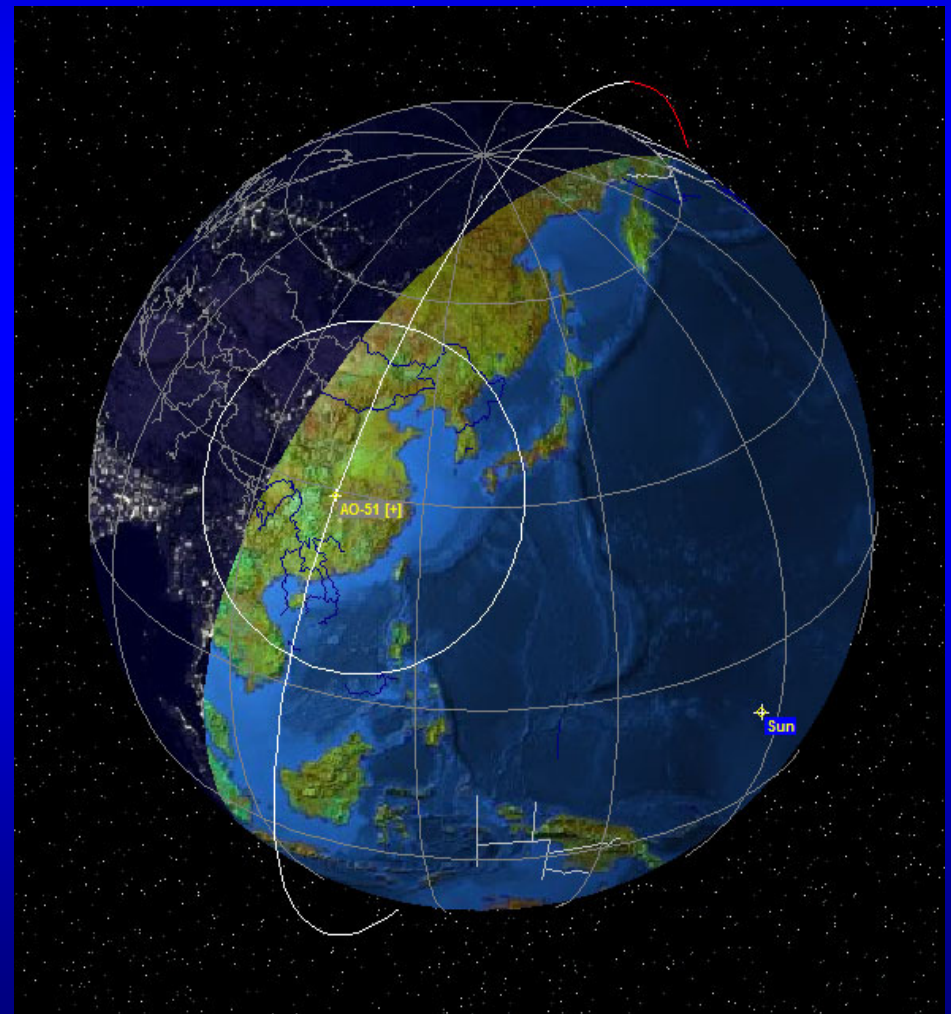
A0-51 Satellite Orbit Flip side



During Orbital
Eclipse Period 6/08

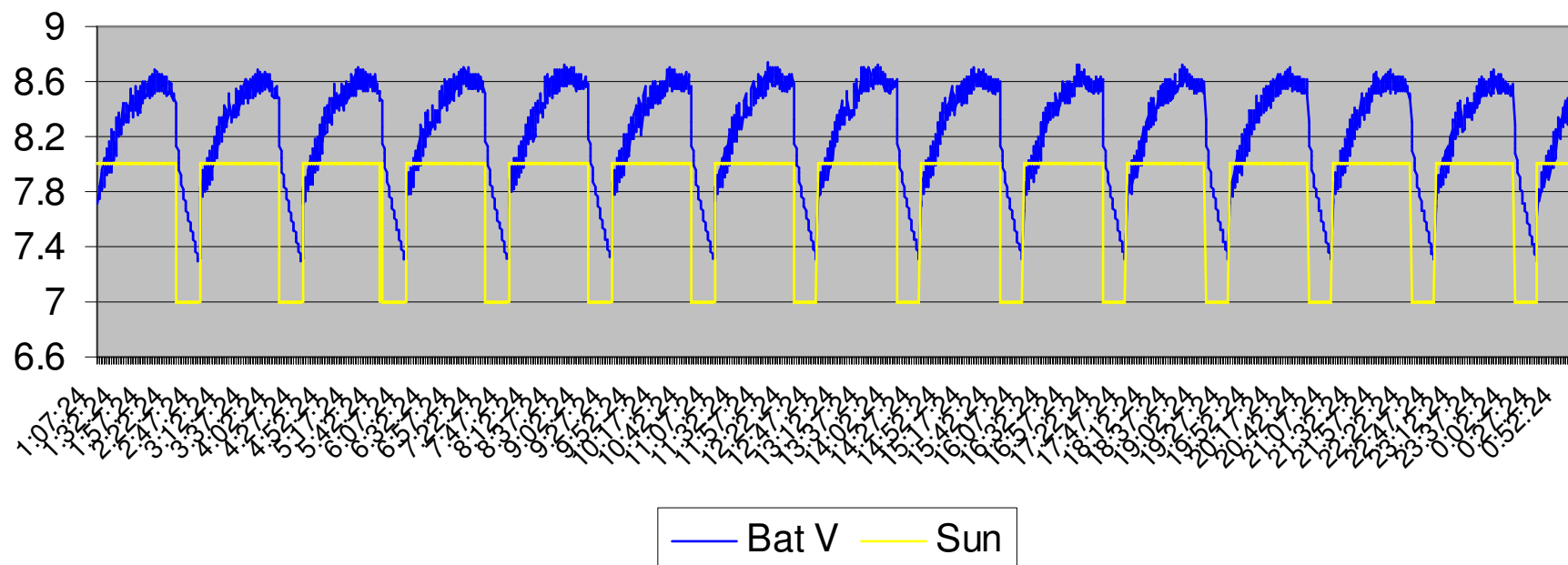


During Orbital No
Eclipse Period 10/08



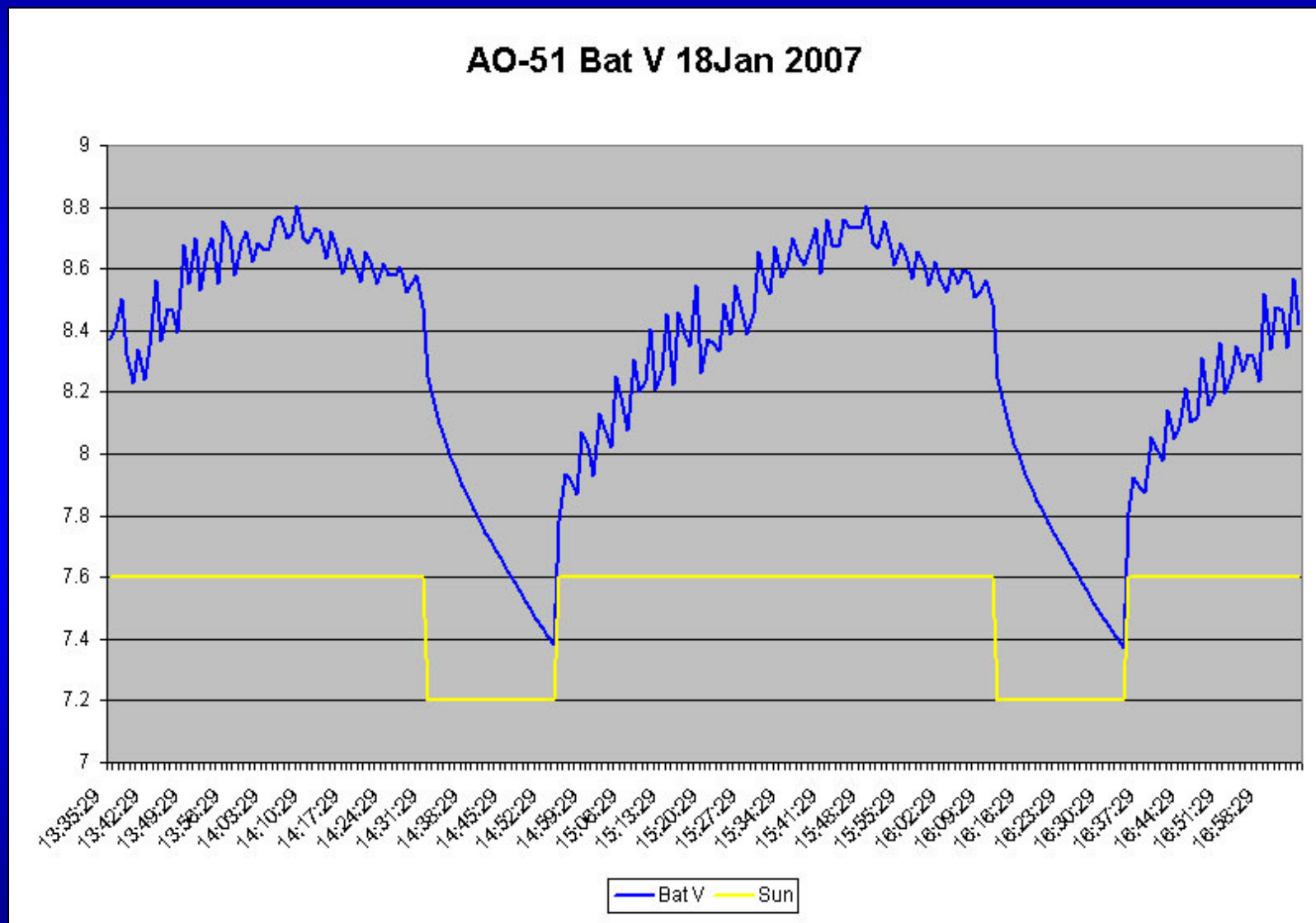
AO-51 Transmit Power and Eclipse Time

30Mar07 AO-51 Batt V

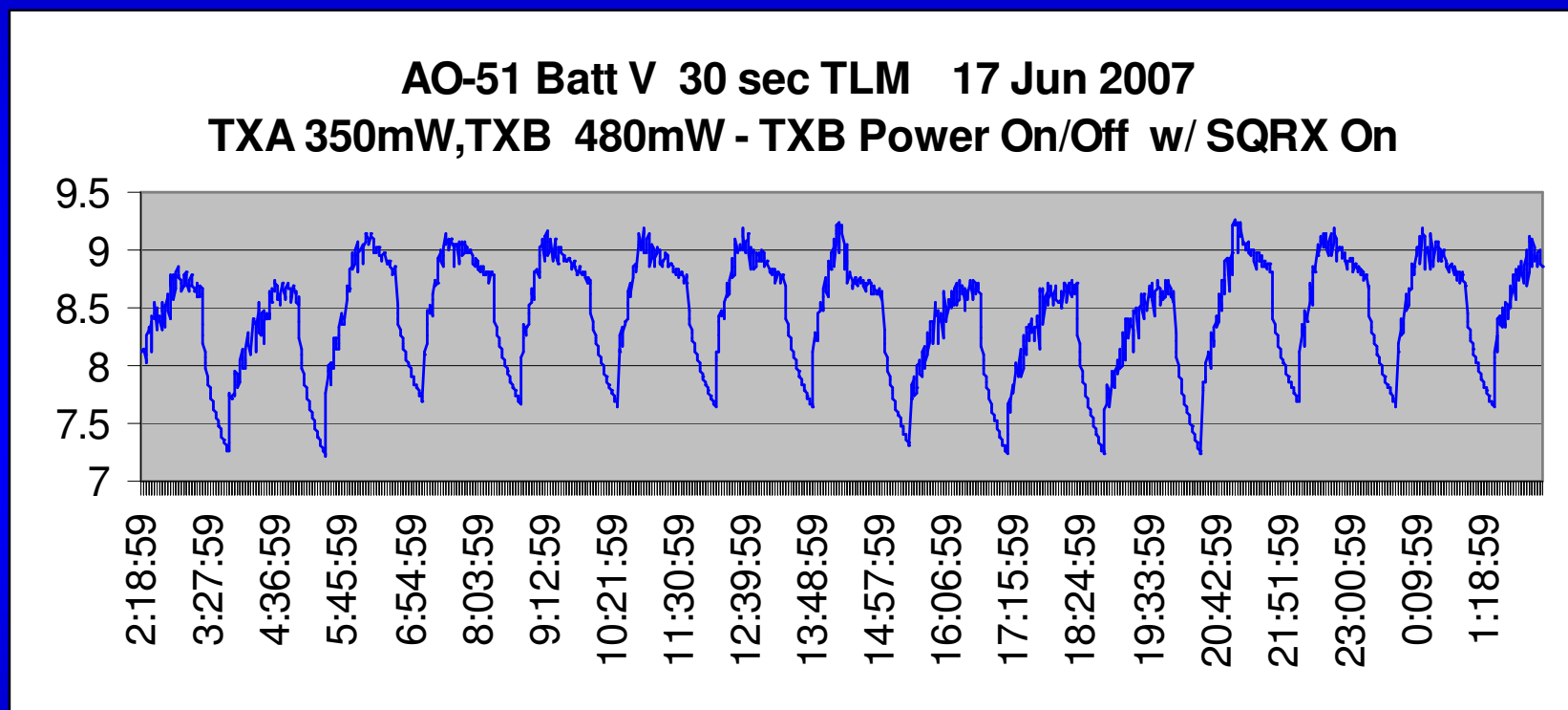


We generally use about 1W TX power during eclipse operation

AO-51 Solar Power & Eclipse



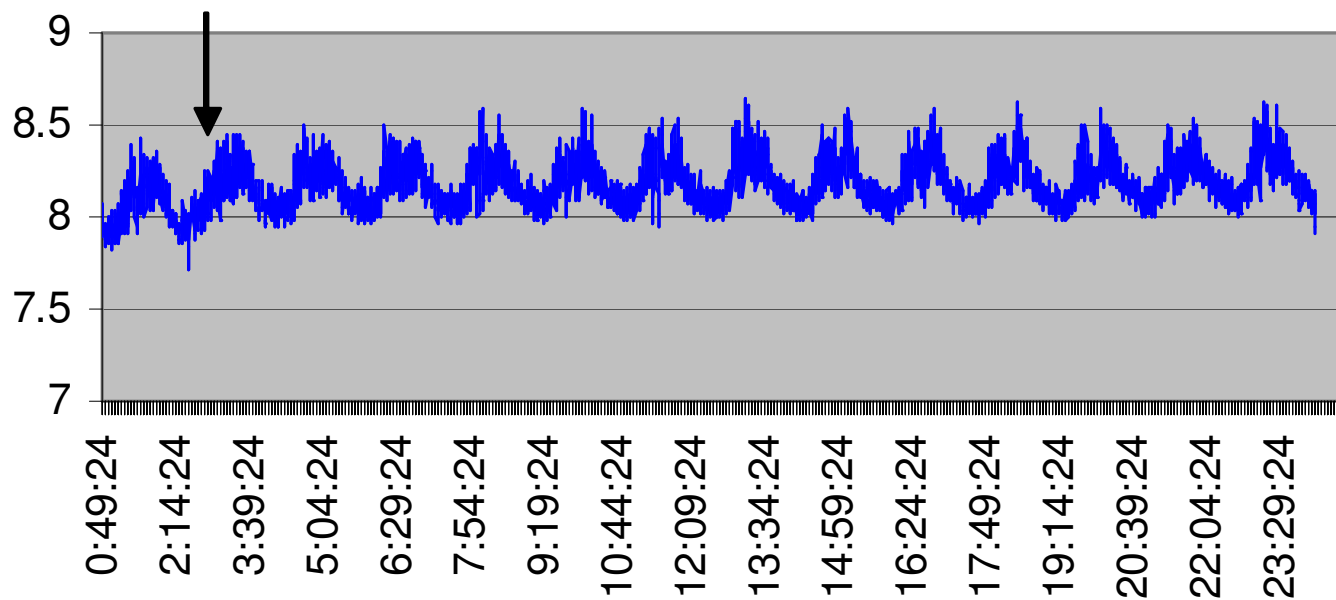
AO-51 Battery Voltage Changes With Power Changes



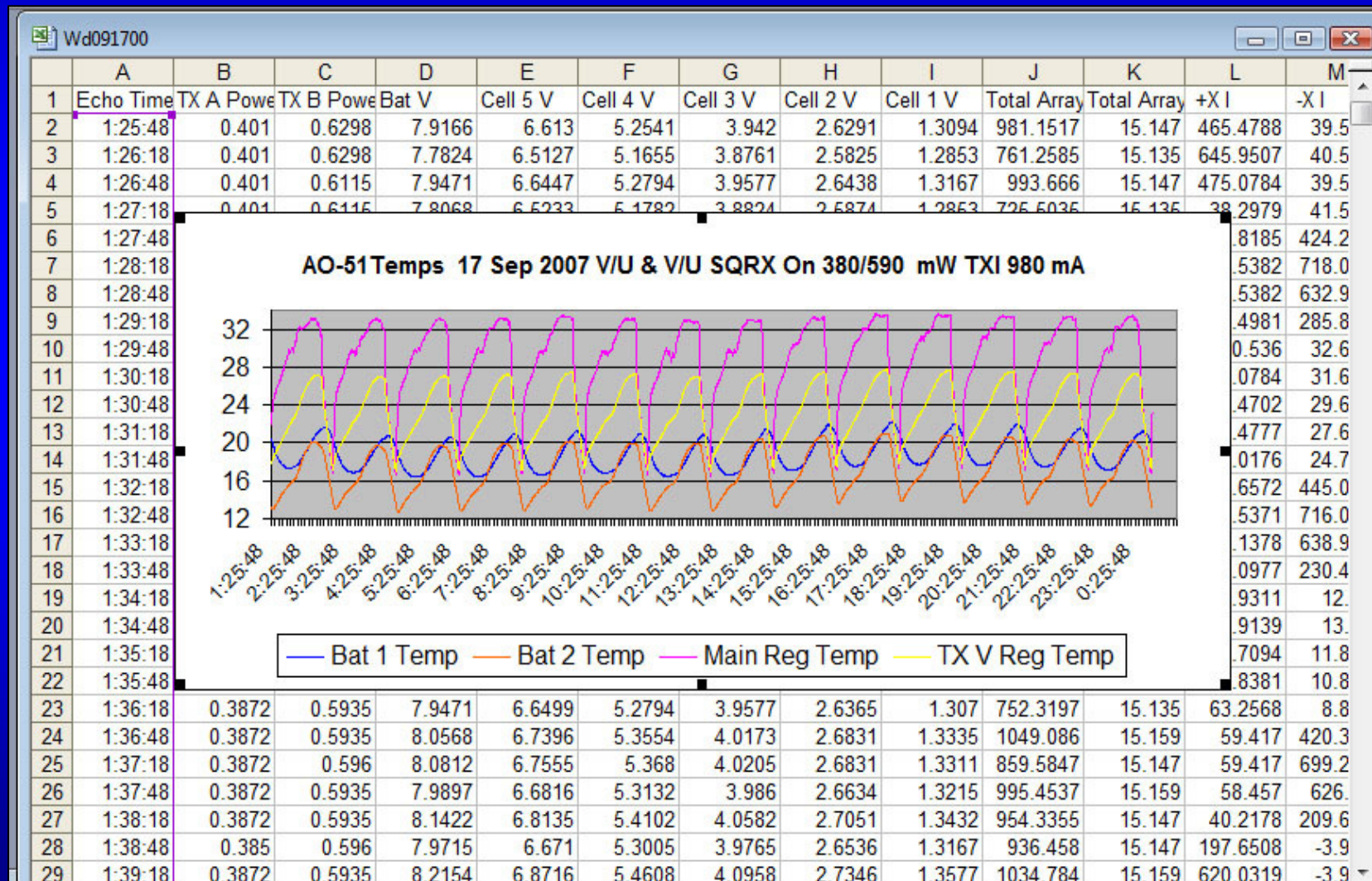
TX I changed from 880mA to 440mA

AO-51 Battery Voltage During No Eclipse Time

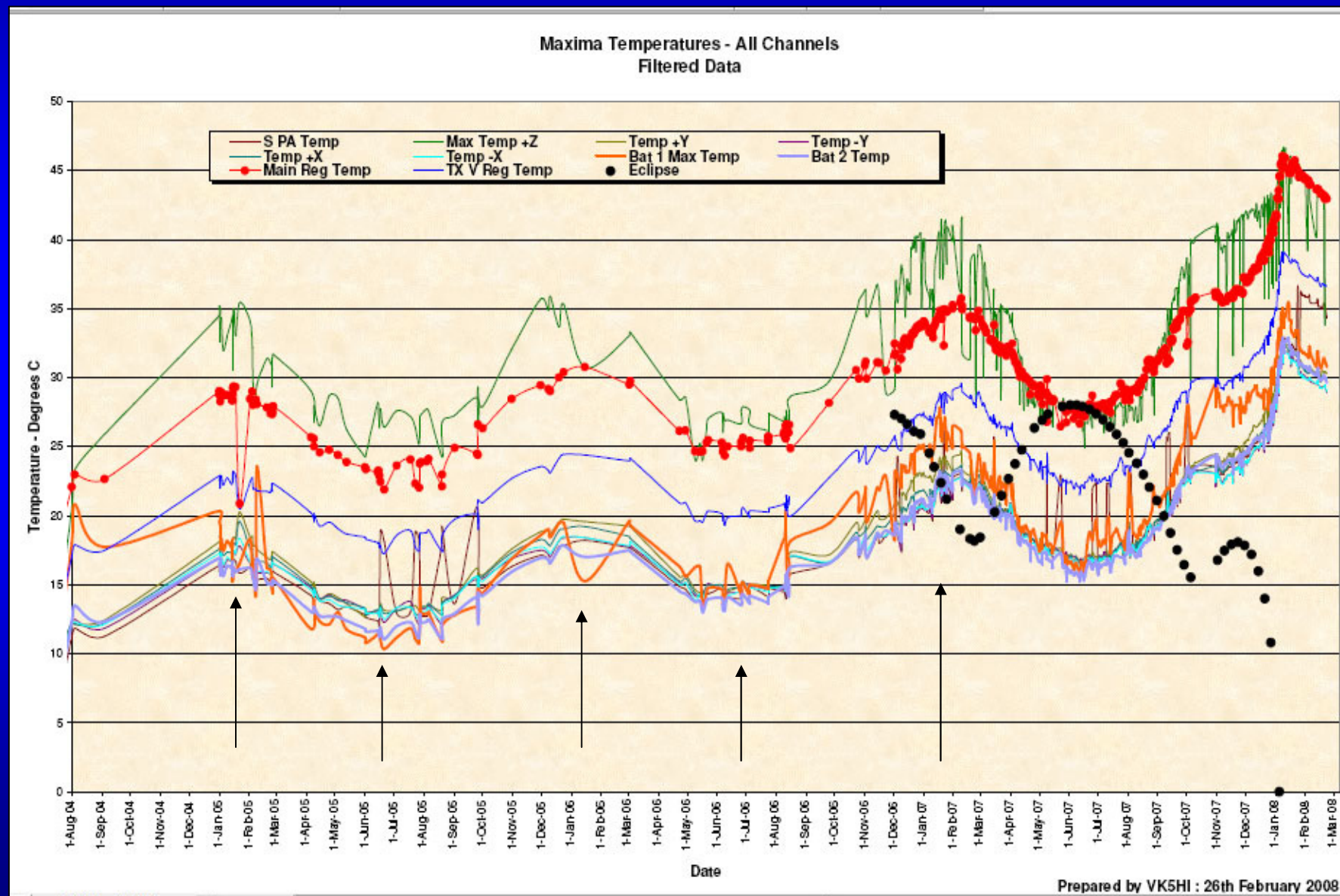
AO-51 Bat V 13 Feb 2008 no eclipse
TXA 940/000 TXB 660 S 0/1.2W TXI 1.3/1.26 A



AO-51 Temperatures



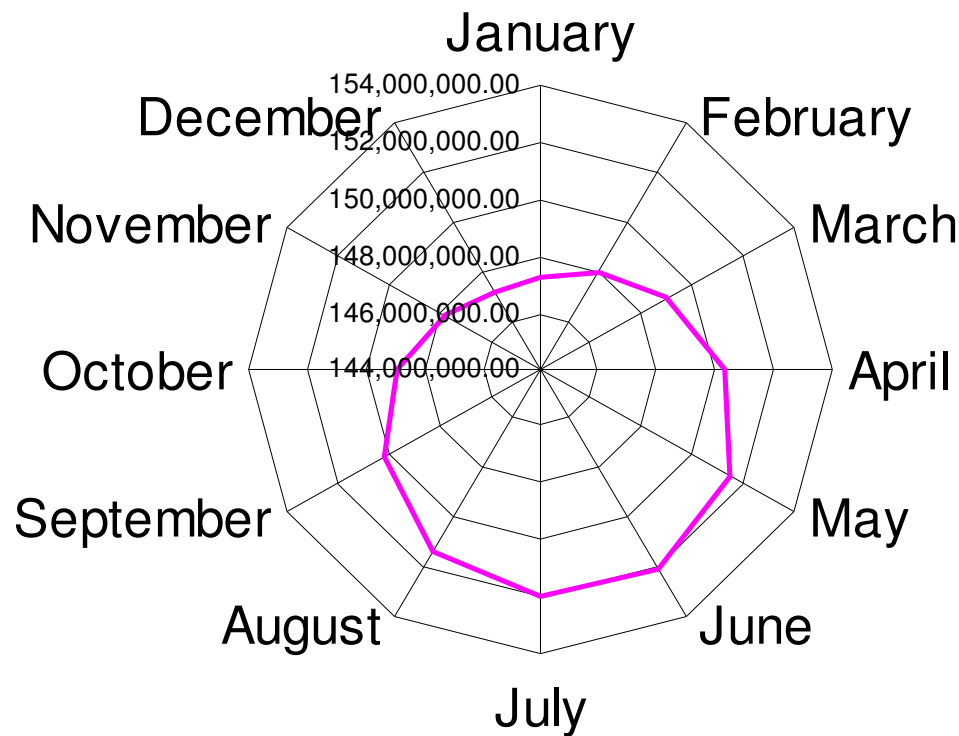
AO-51 Lifetime Temperatures



AO-51 Sun Distances



Earth-Sun Distances

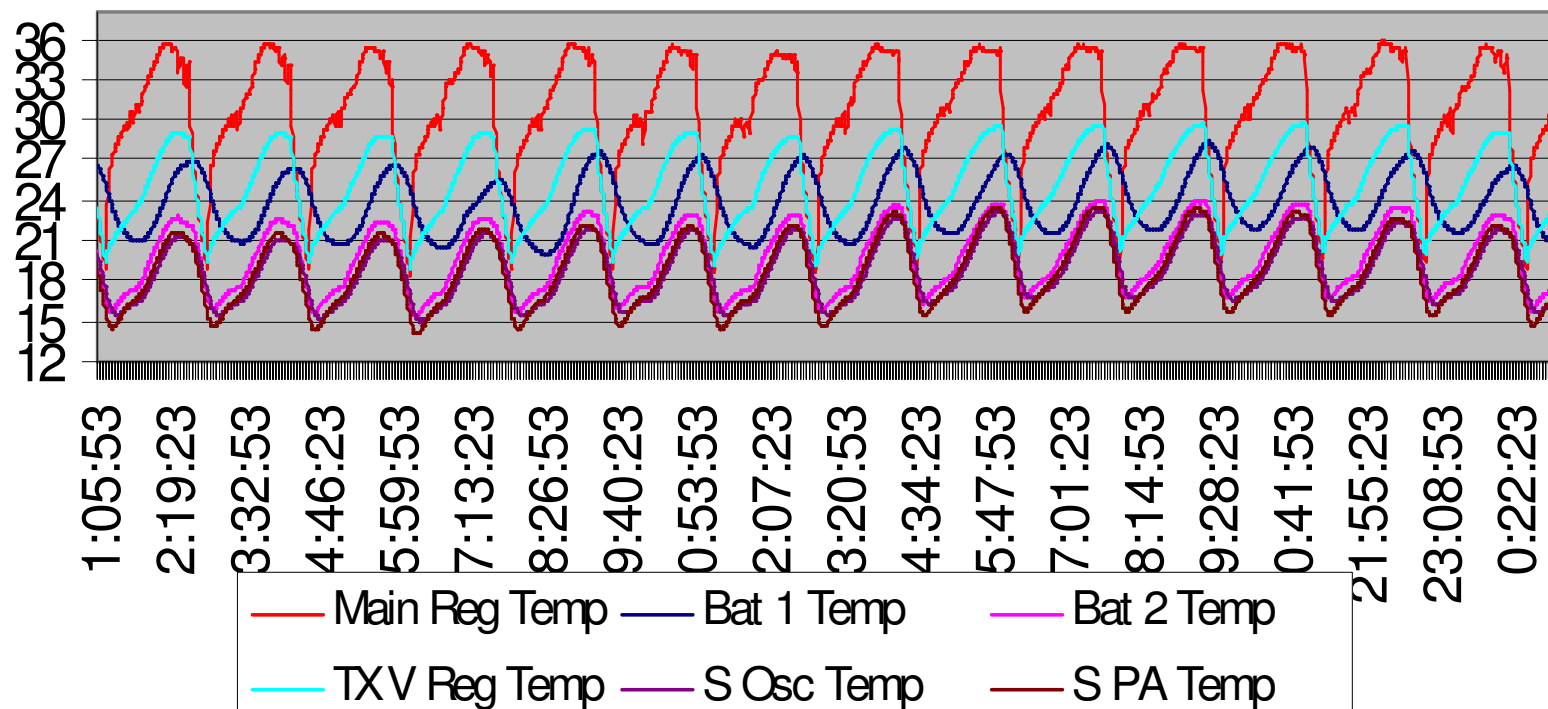


~3 million miles
difference

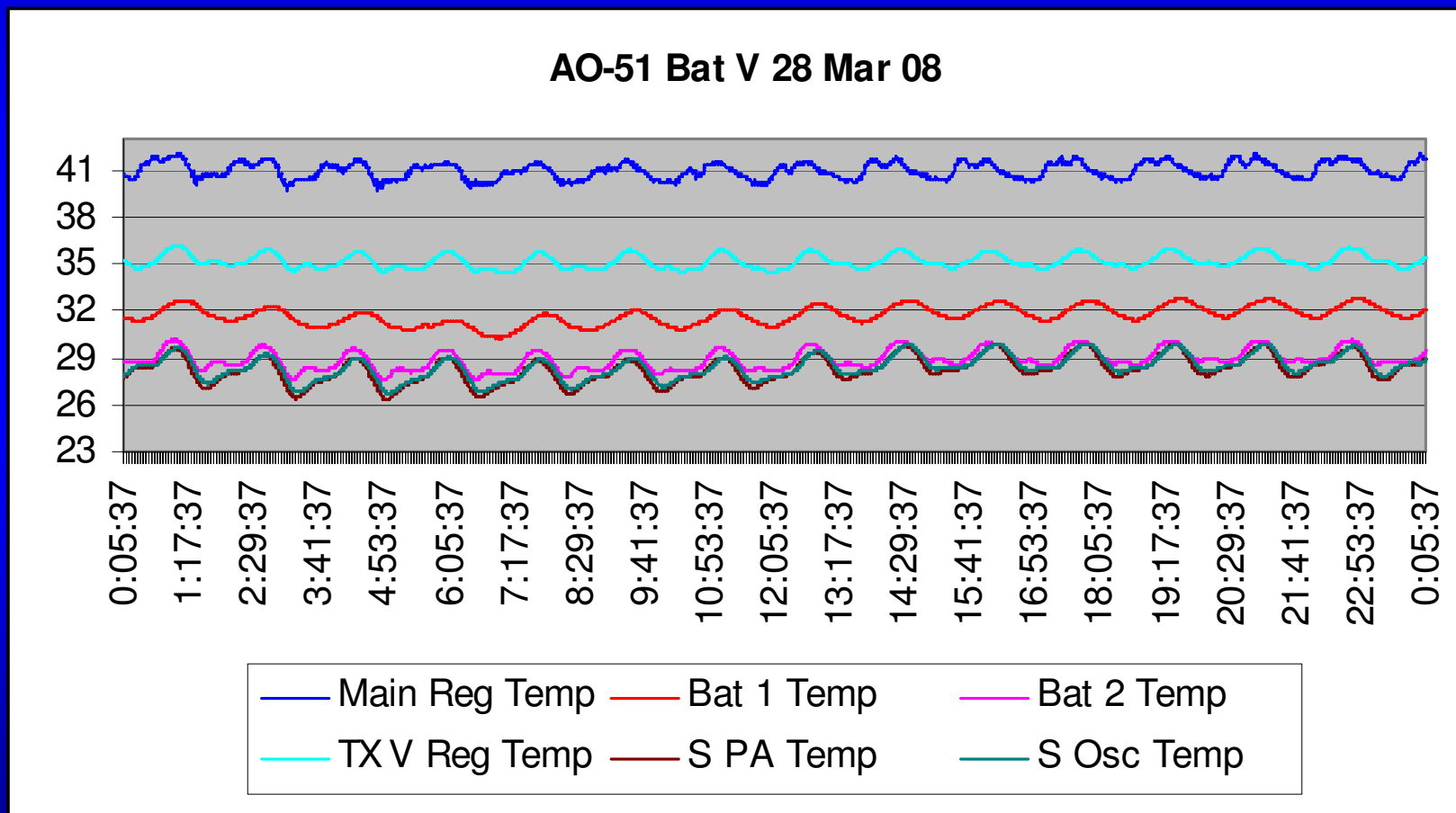
AO-51 Fall Temps before no eclipse TX 0.88W



AO-51 Bat V 14 Nov 2007



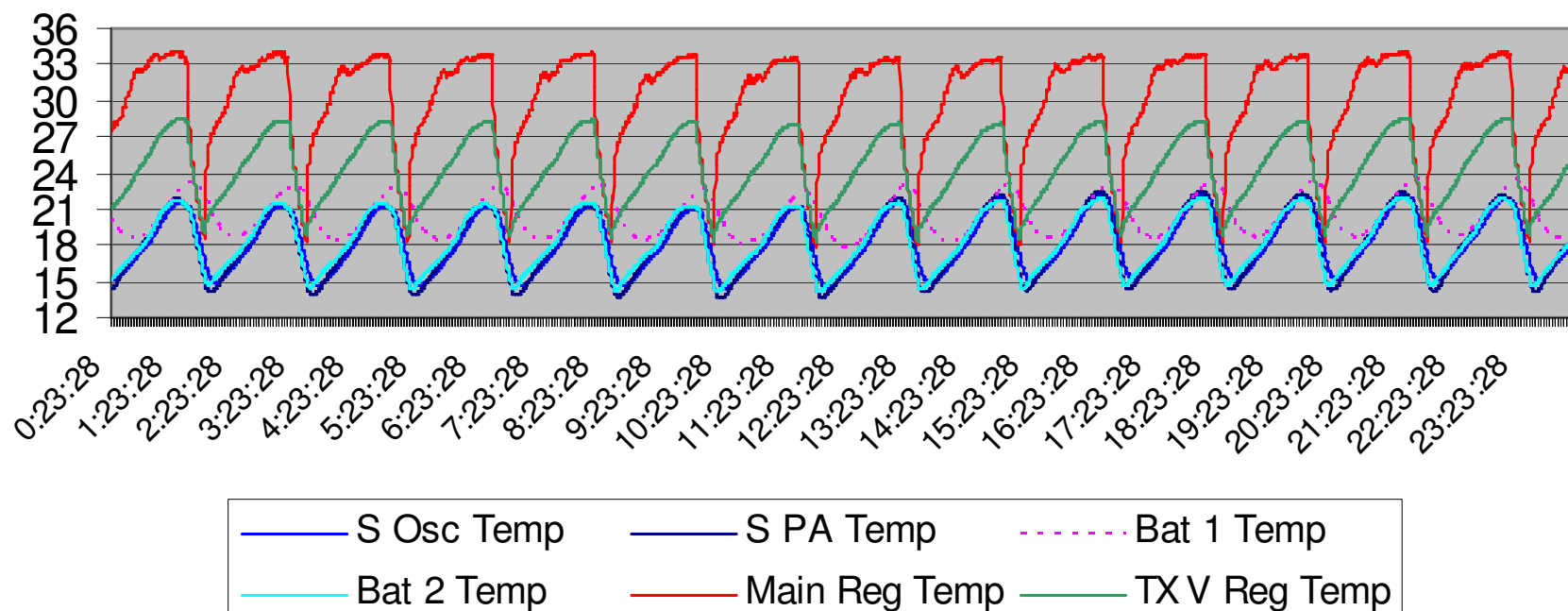
AO-51 Spring Temps during no eclipse TX 1.42W



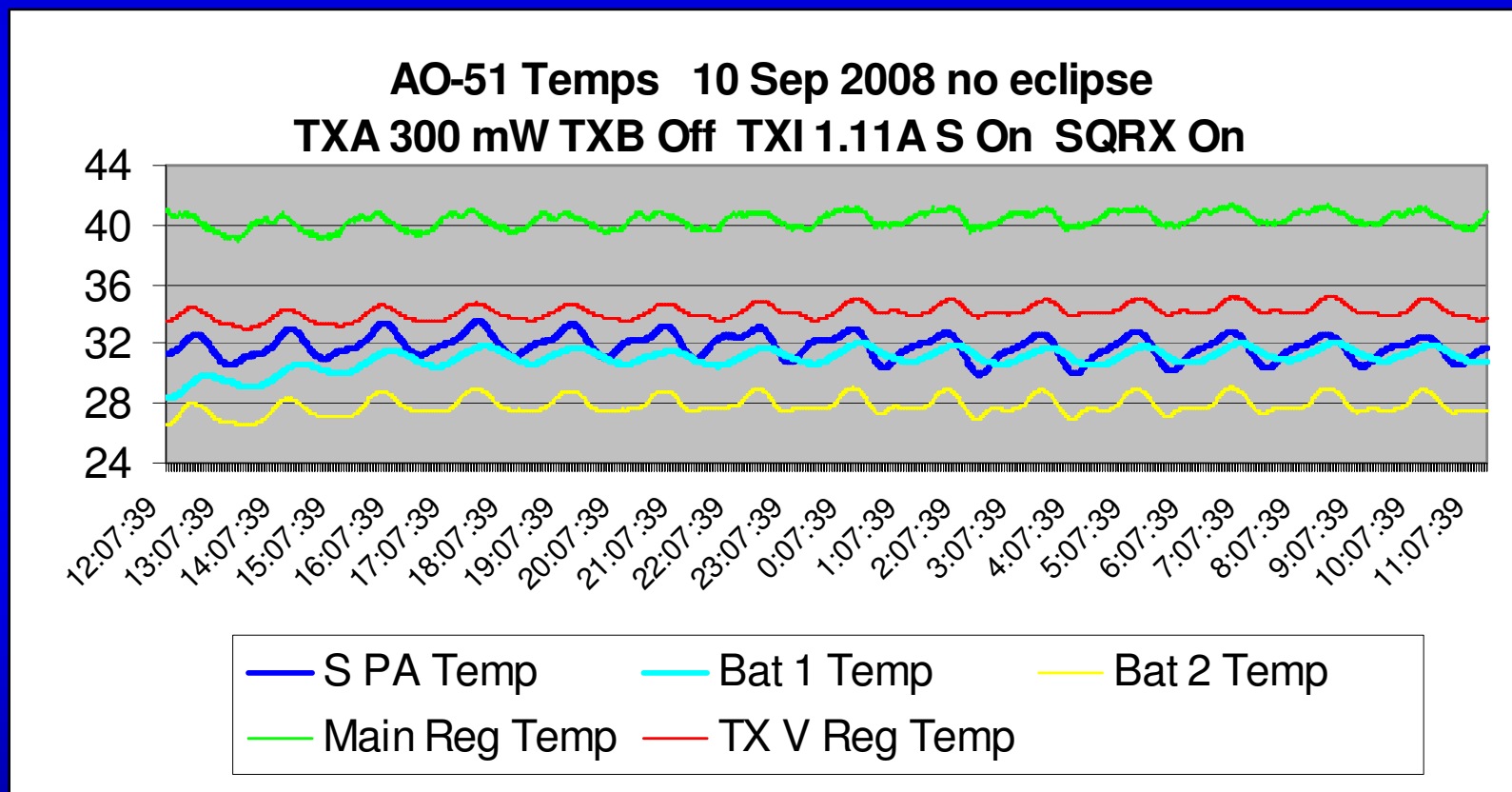
AO-51 temps post no eclipse TX 0.97W



AO-51 Temps 29 Apr 2008



AO-51 Temps second no eclipse TX 1.1 W

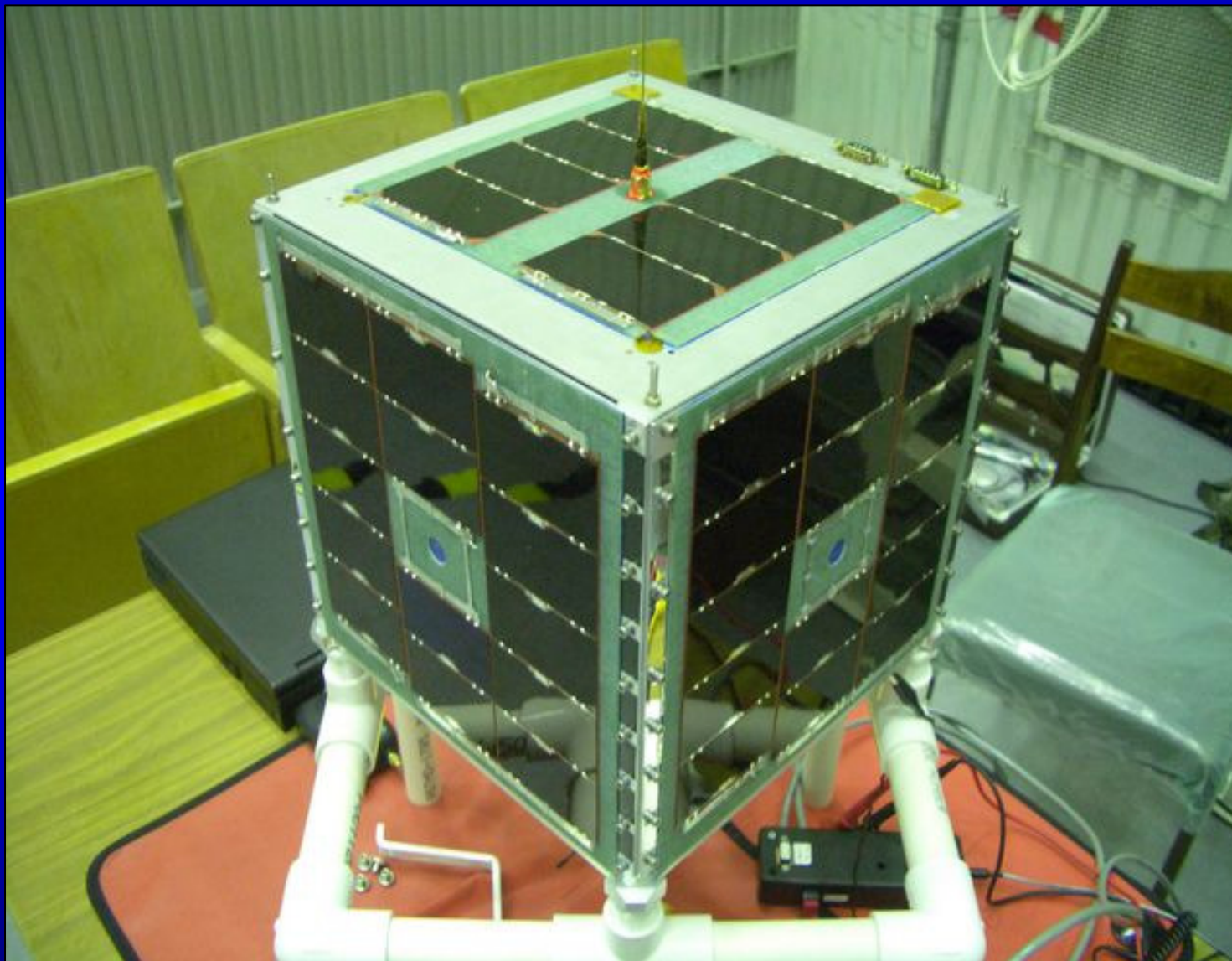


AO-51 Temperature Summary



		Batt 1	Batt 2 (chassis)	Main Reg	TX V Reg
Fall 2008	No eclipse	31	28	41	35
Summer 2008	eclipse	20	16	24	20
Spring 2008	eclipse	20	12	26	23
Winter 2008	No eclipse	32	31	44	37
Fall 2007	eclipse	20	19	27	25
Summer 2007	eclipse	14	12	18	15
Winter 2007	eclipse	20	15	23	20
Summer 2006	eclipse	11	9	15	13
Winter 2006	eclipse	15	12	20	17

AO-51 Array Current



14 cells on
 $\pm X$ & $\pm Y$

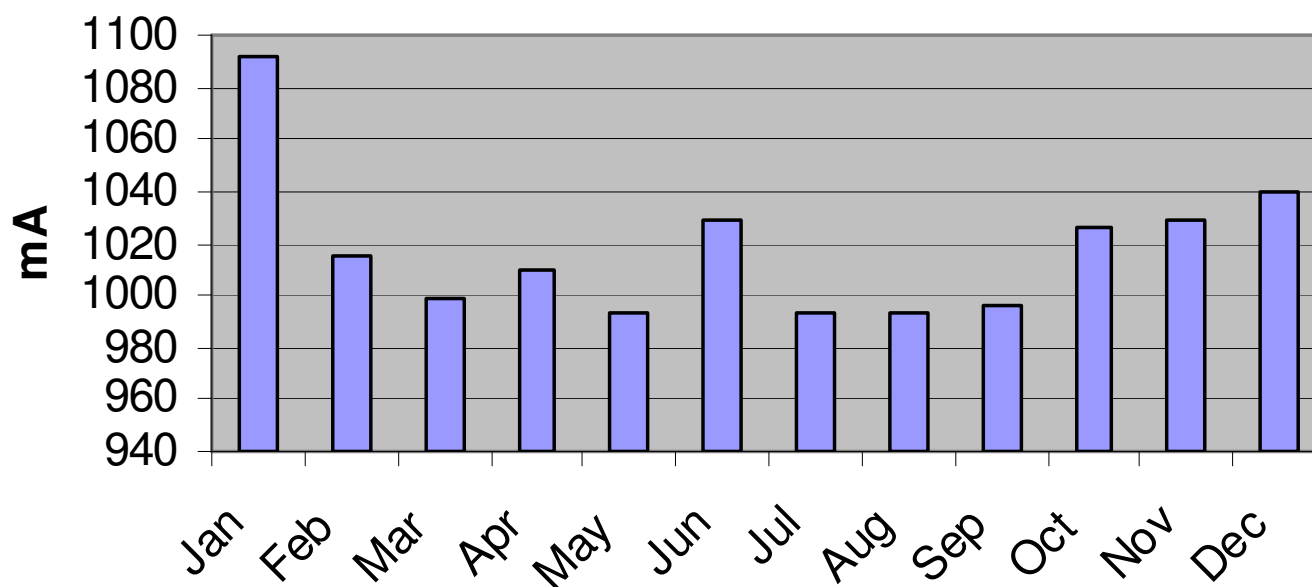
7 cells on $\pm Z$

$\sim 20W$

2006 AO-51 Solar Production

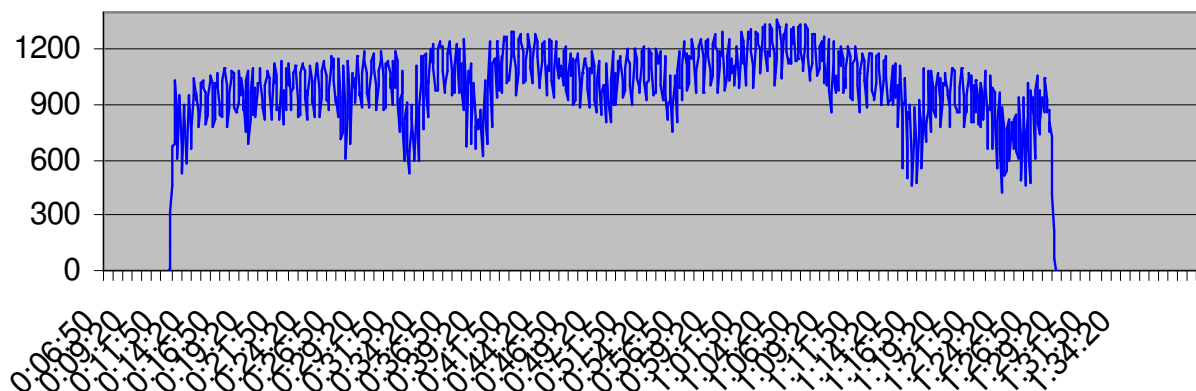


AO-51 Median Total Array I 2006

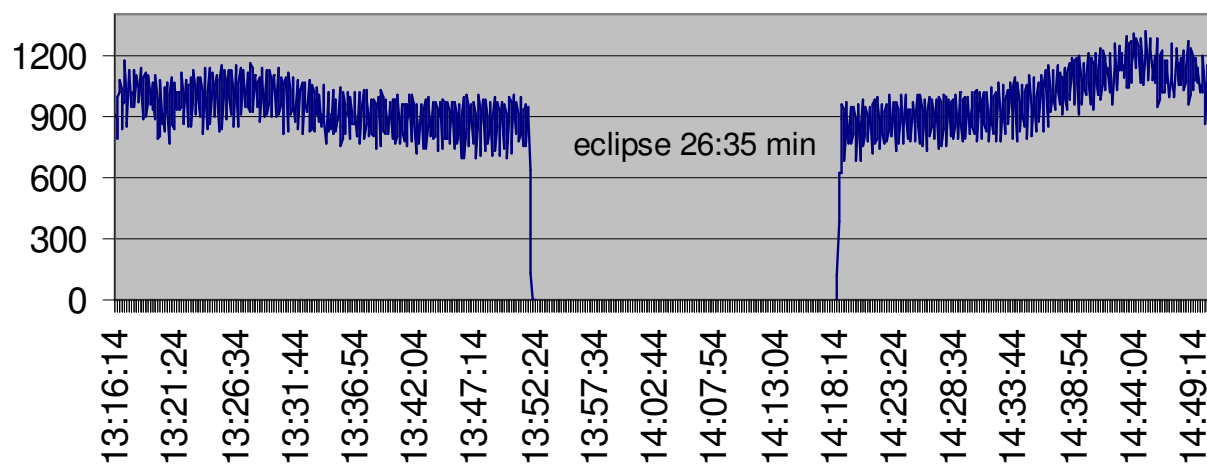


2007 AO-51 Solar Production

AO-51 Total Solar Array Current 10 Jan 2007 5 sec



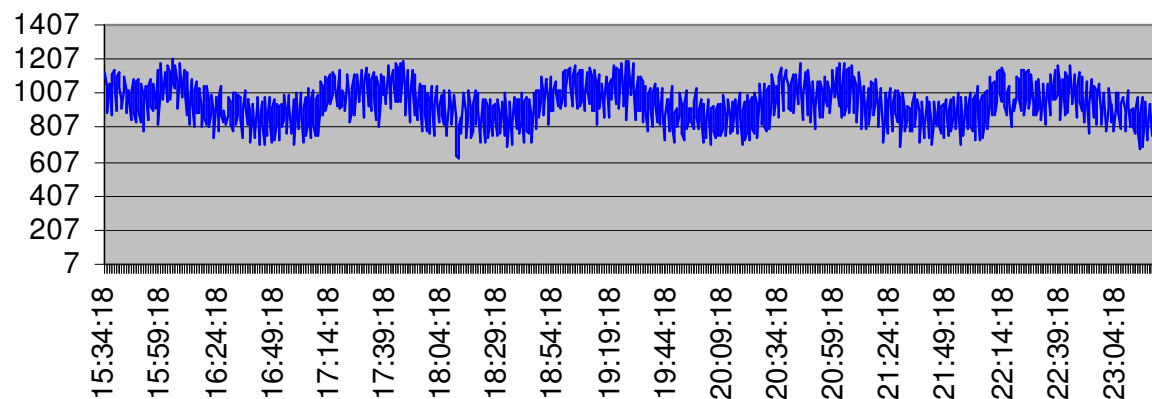
AO-51 Total Solar Array I 14 Jul 2007 5 sec TLM



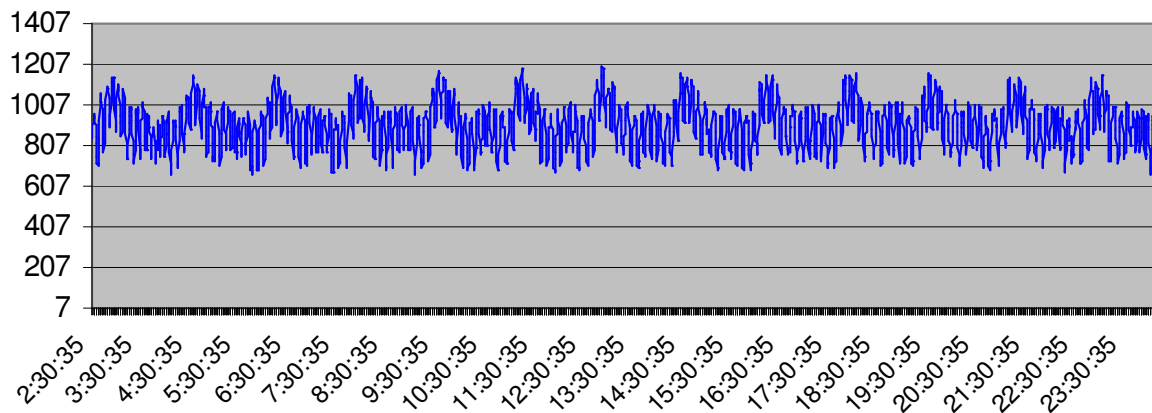
2008 No Eclipse AO-51 Solar Production



AO-51 Array Currents 15 Jan 2008



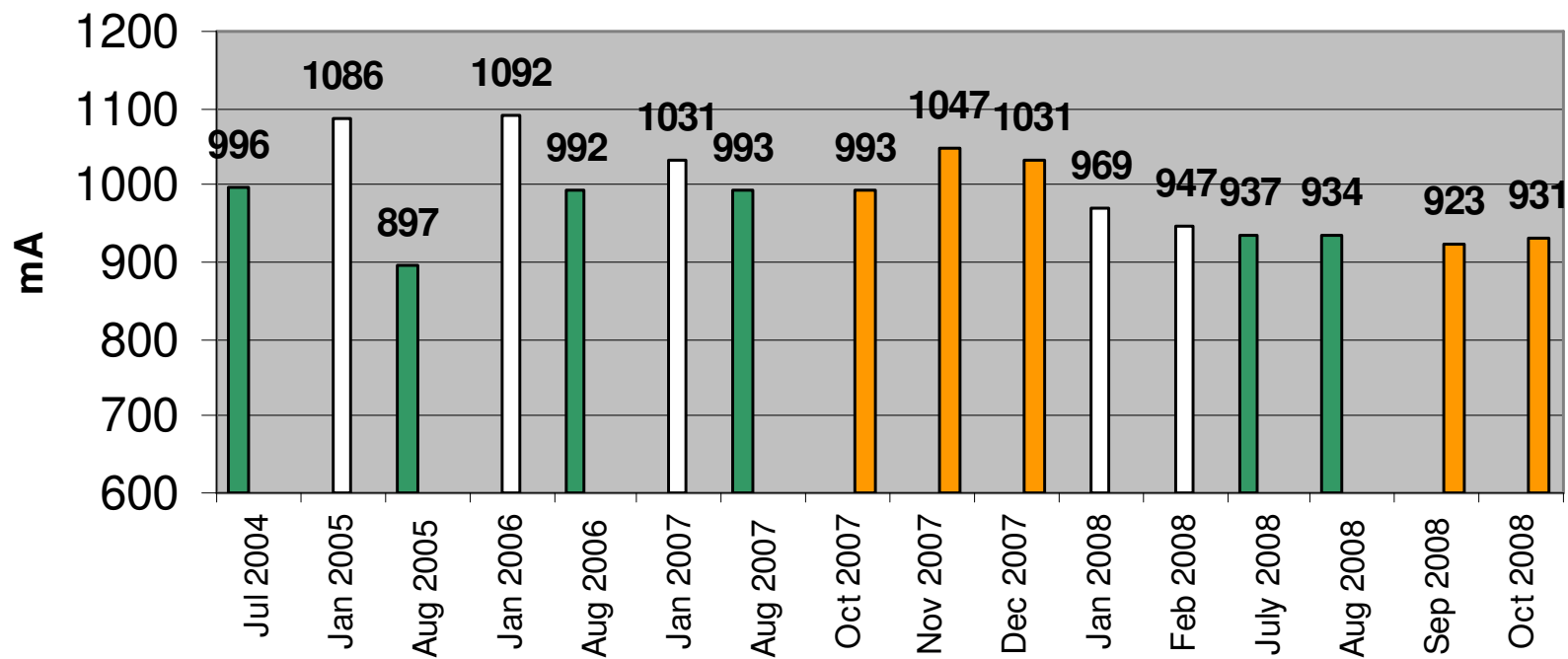
**AO-51 Array Current 22 Aug 2008
30 sec TLM**



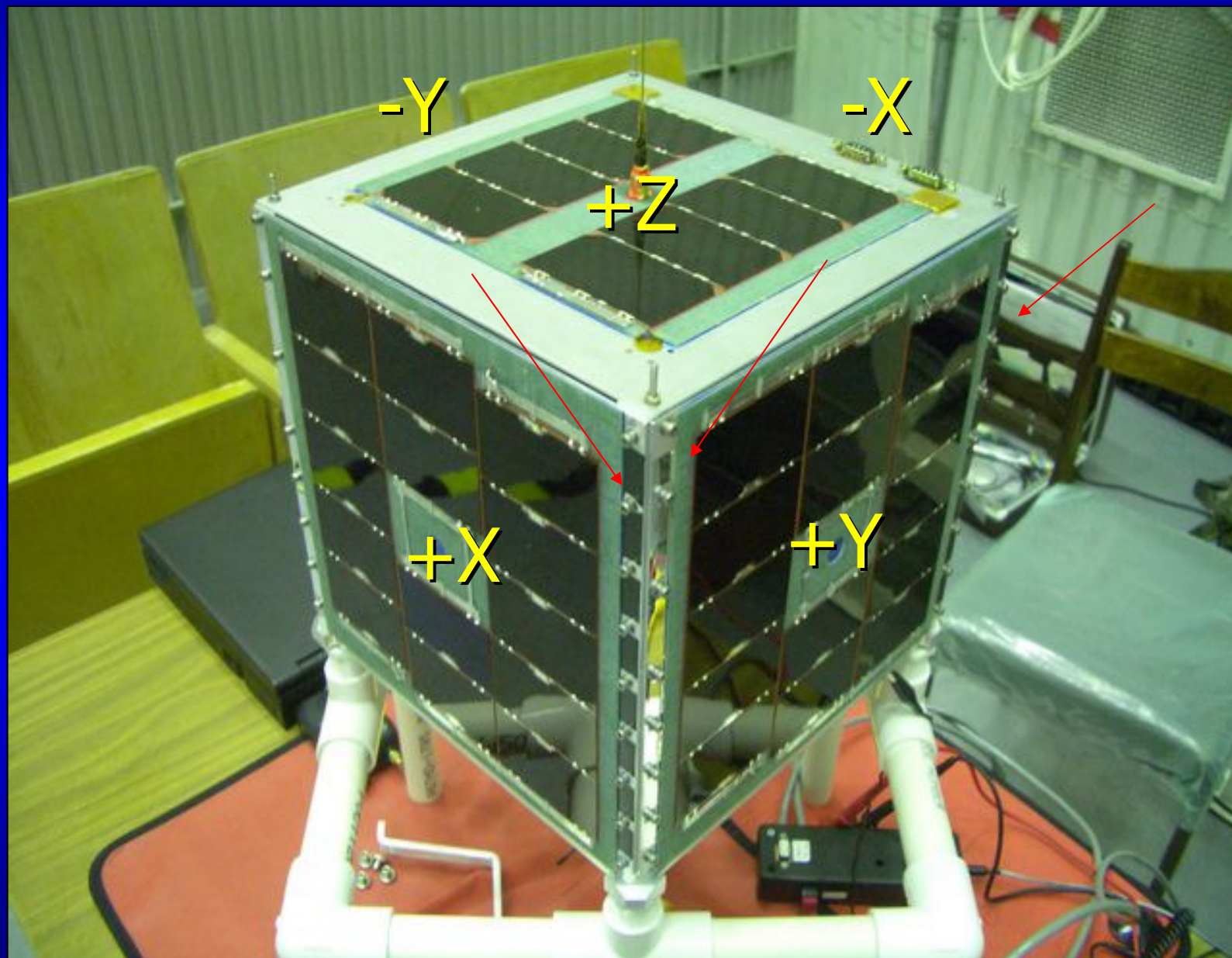
AO-51 Solar Production Summary



AO-51 Sample Median Array Current for One Pass



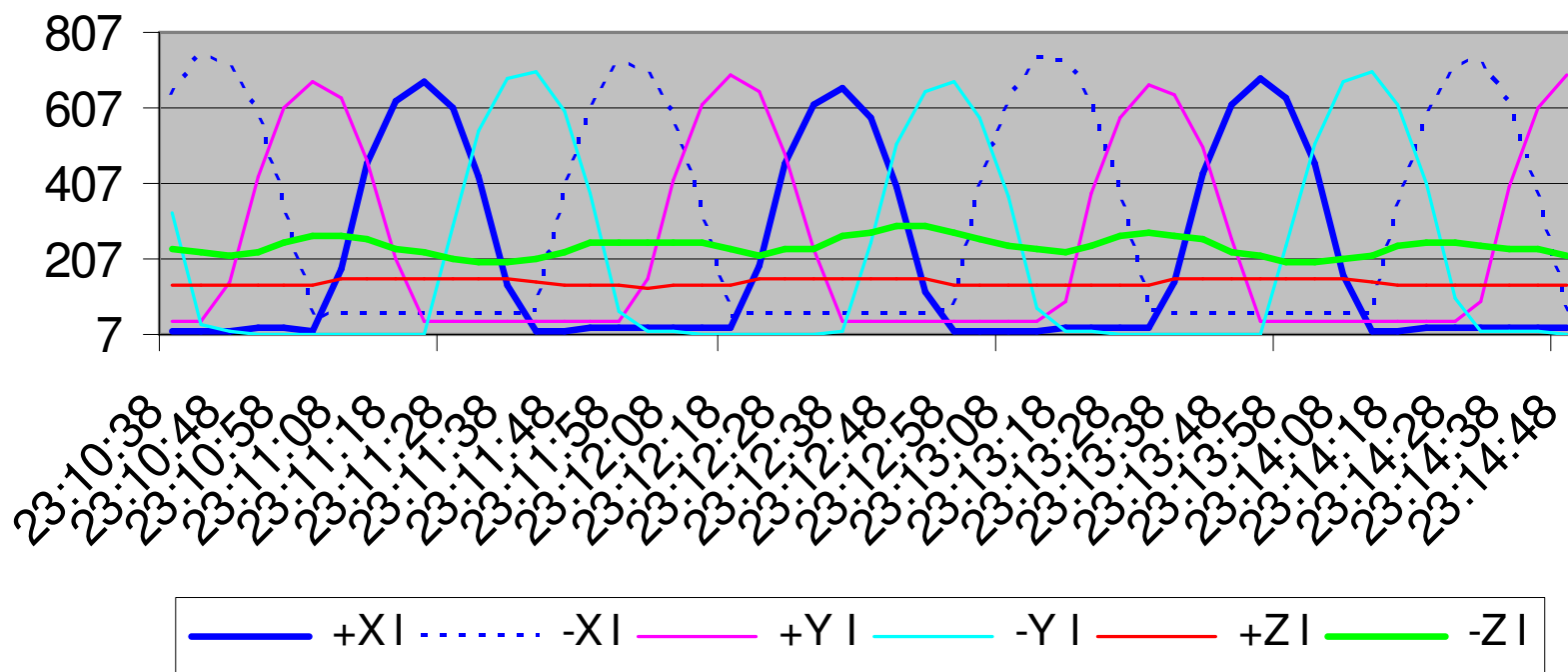
AO-51 Spin



AO-51 Spin Telemetry

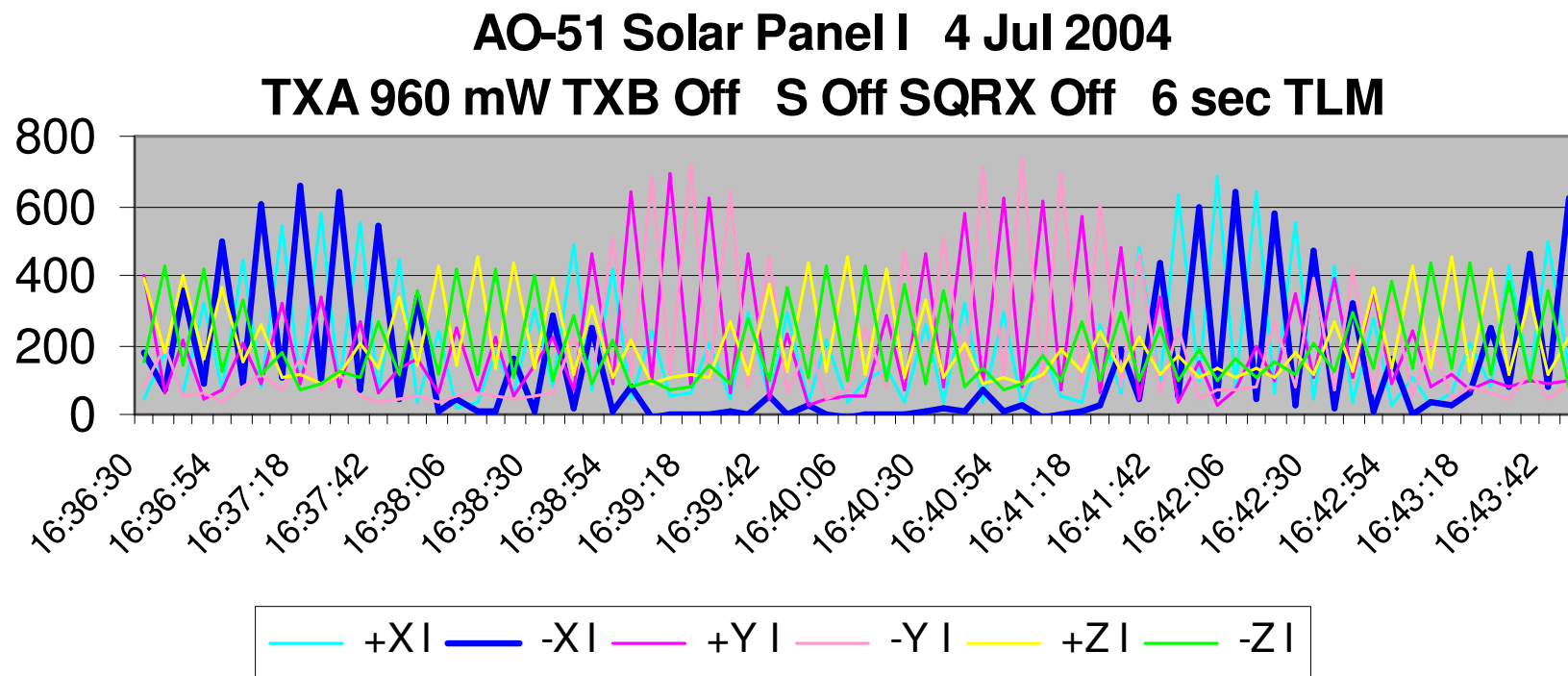


AO-51 Array Current (Spin) 18 Oct 2008 5 sec
TXA 710/400 TXB 1.14 TXI 1.37/1.24 0.8 RPM 75 sec/rev



very good spin sample

AO-51 Spin Soon After Launch

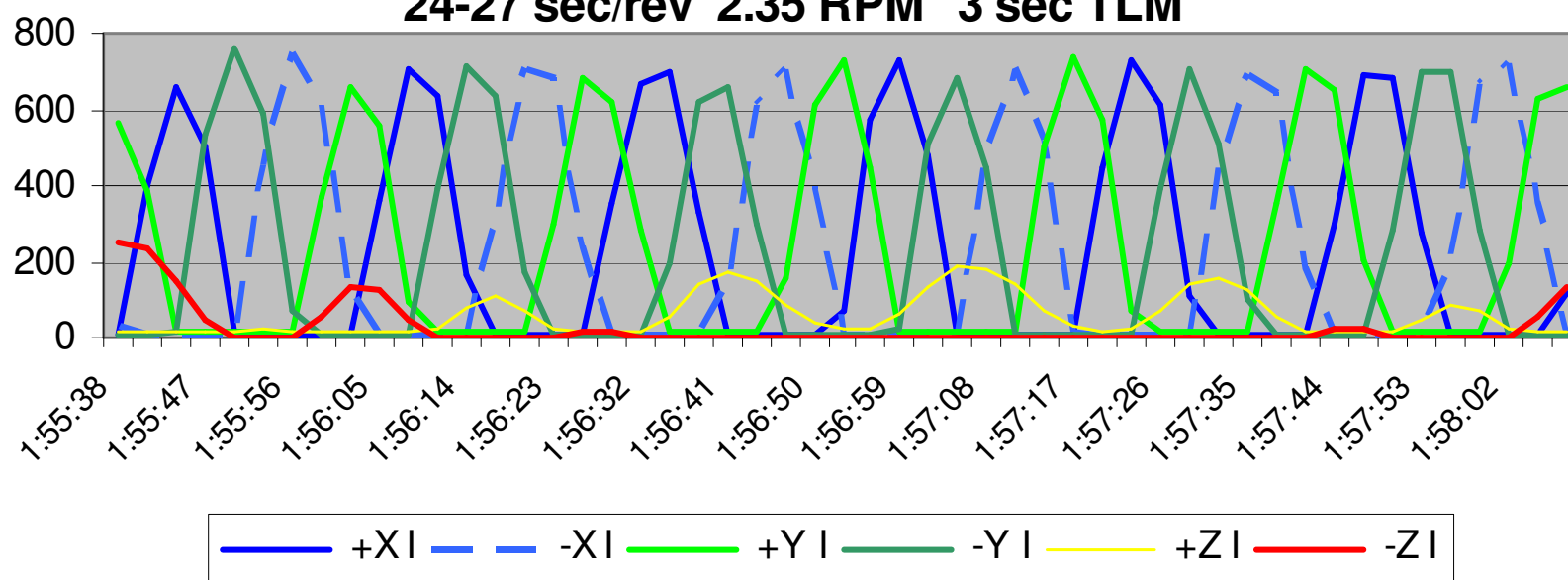


unusable spin sample

AO-51 Spin @ 6 months



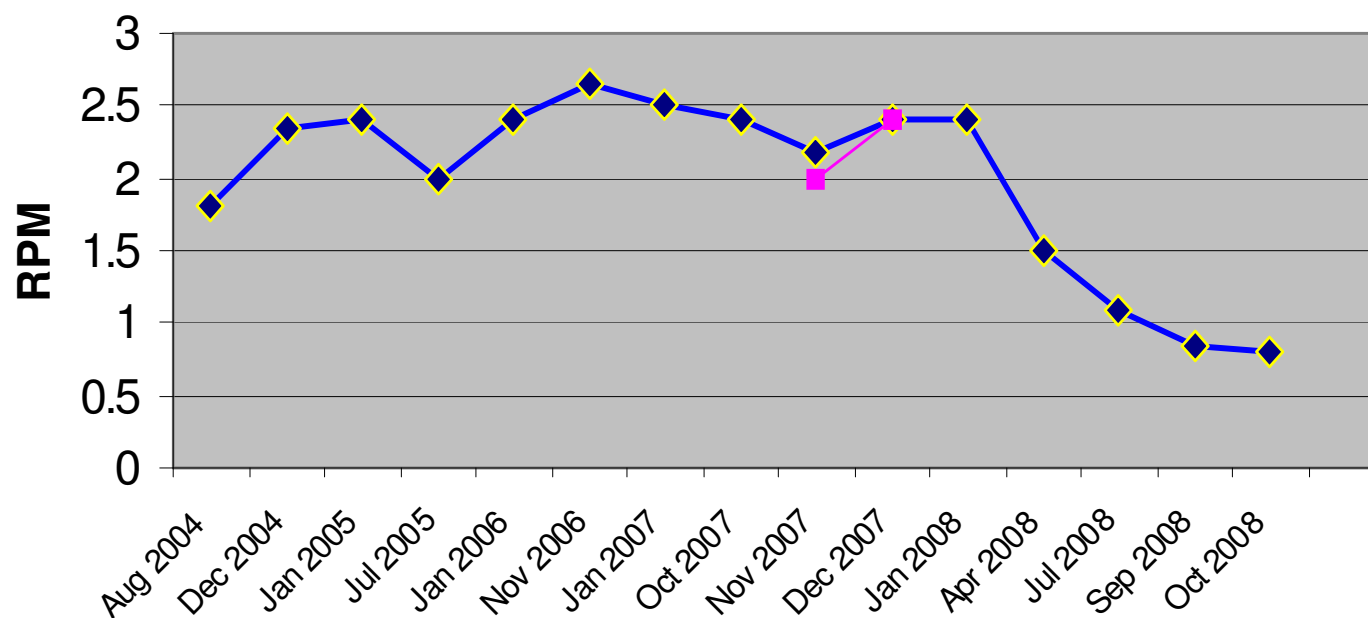
AO-51 Solar Panel I 17 Dec 2004
24-27 sec/rev 2.35 RPM 3 sec TLM



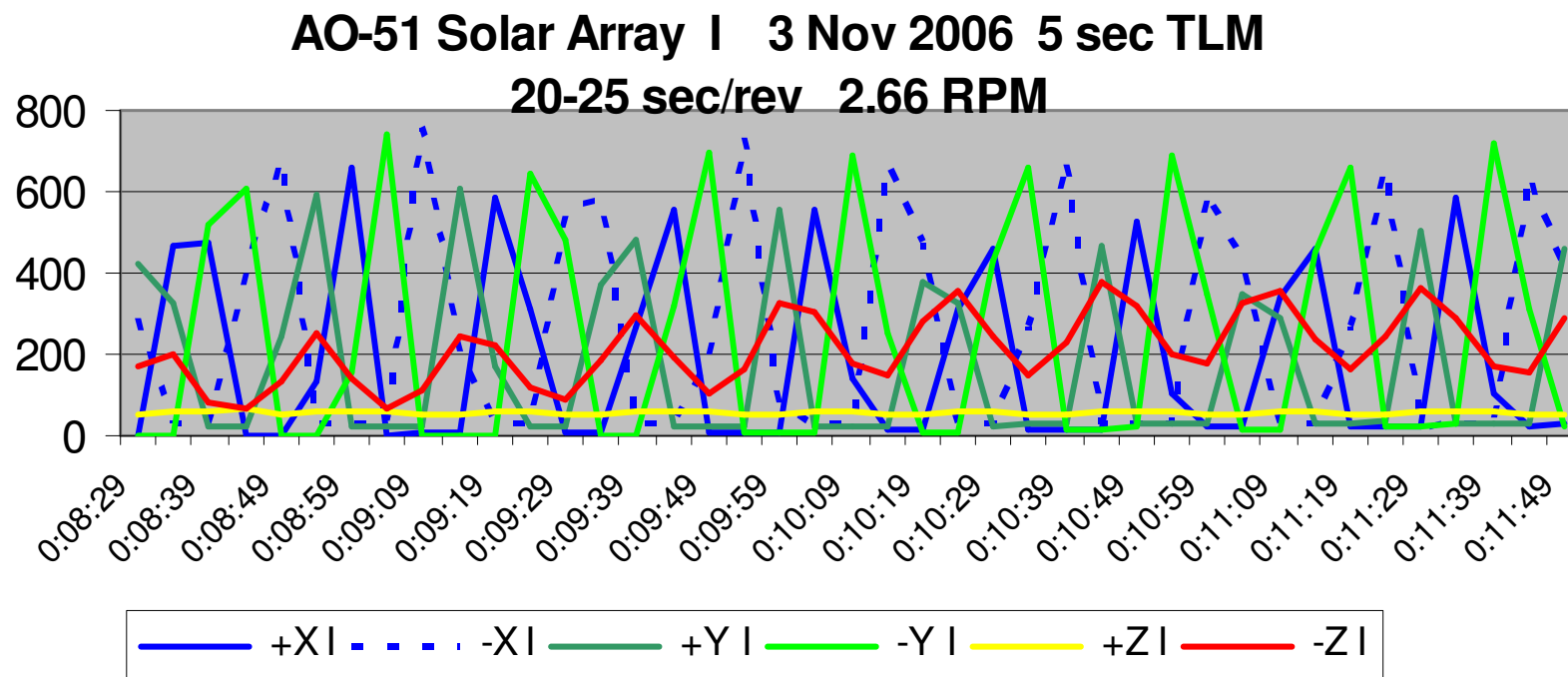
AO-51 Spin



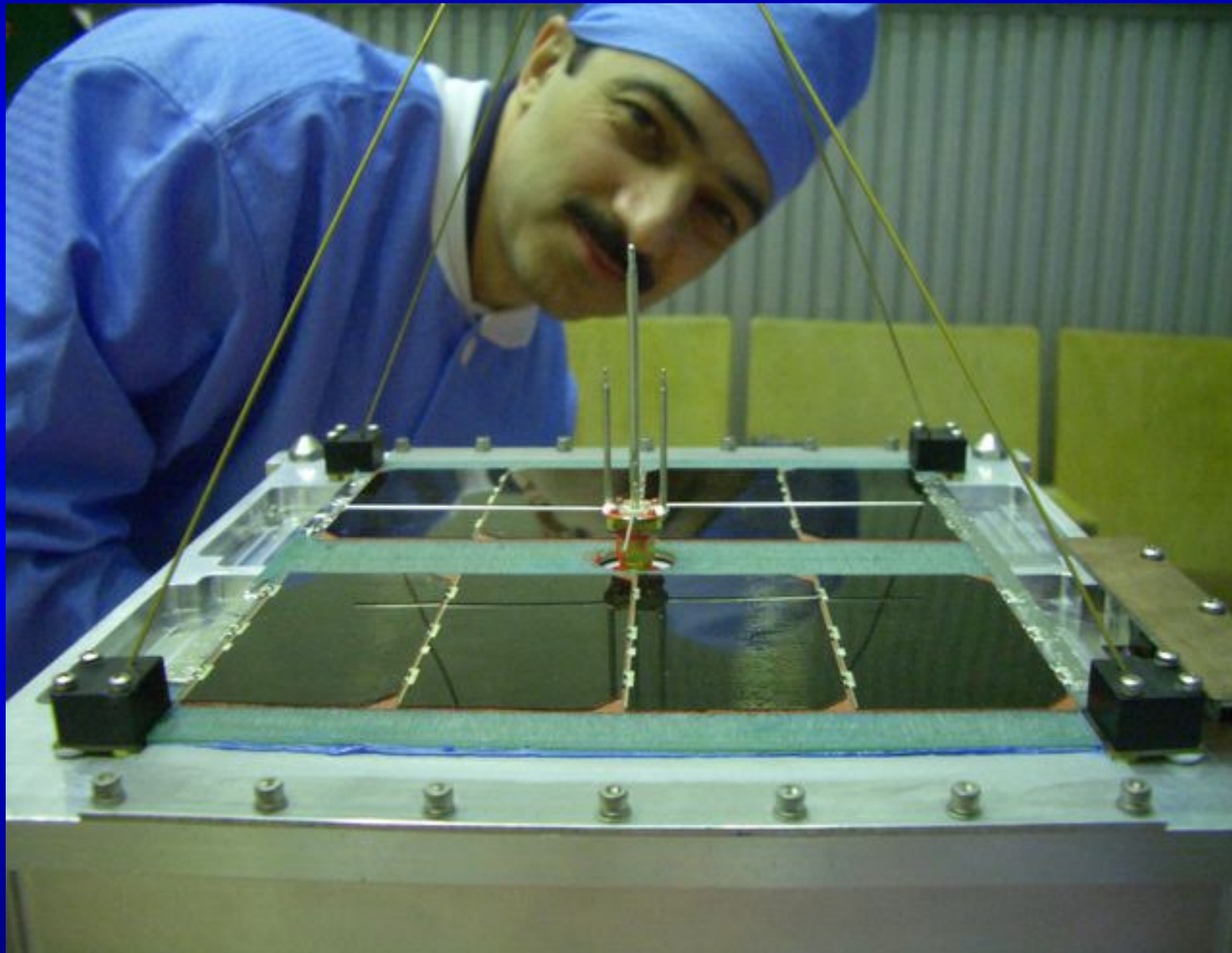
AO-51 Spin Rate



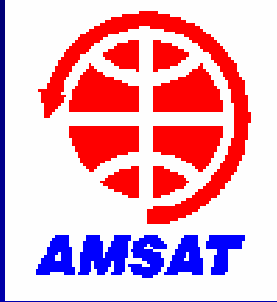
AO-51 Wobble



AO-51 70cm, L & S Antennas

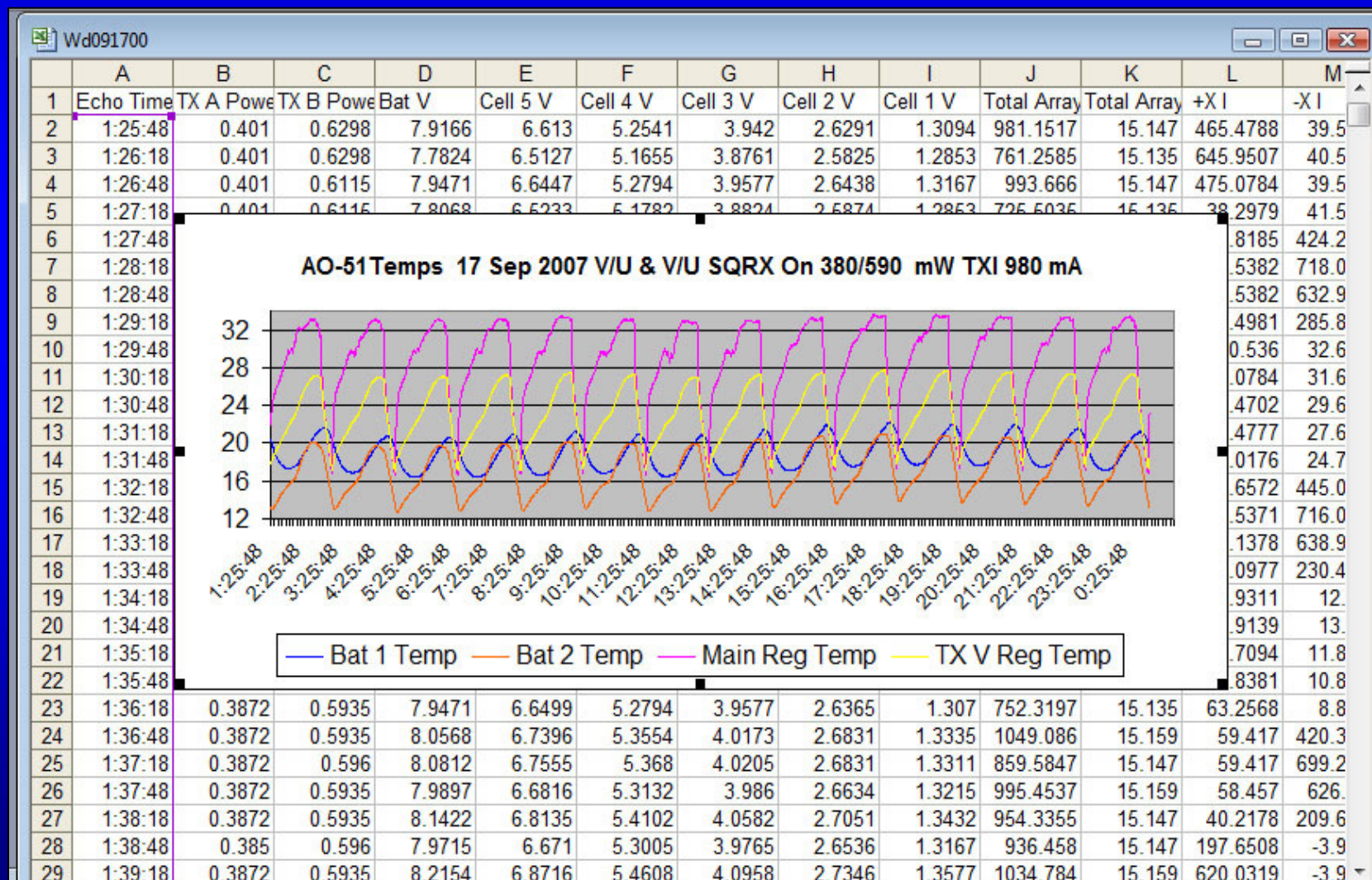


Summary



- AO-51 will spend a good deal of the next few years in a no eclipse orbit
- During no eclipse orbits, the satellite tends to track the grey line
- No eclipse periods mean higher TX power
- No eclipse periods mean a warmer satellite
- AO-51 spin rate is decreasing – what will it do?

Any Volunteers to help study the telemetry?



Questions?